

PHYSICS

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Basic Maths (Trigonometry)

RACE # 01

1. Convert the angle from degree to radian :

- (a) 30° (b) 45°
(c) 60° (d) 90°
(e) 120° (f) 135°
(g) 210° (h) 270°
(i) 315°

2. Convert the following angle from radian to degree

- (a) $\frac{\pi}{4}$ rad (b) $\frac{\pi}{6}$ rad
(c) $\frac{\pi}{3}$ rad (d) $\frac{3\pi}{4}$ rad
(e) $\frac{7\pi}{6}$ rad (f) $\frac{5\pi}{4}$ rad
(g) $\frac{5\pi}{2}$ rad (h) $\frac{7\pi}{4}$ rad
(i) $\frac{5\pi}{3}$ rad

3. Find the value of following :-

- (a) $\sin 150^\circ$ (b) $\sin 135^\circ$
(c) $\cos 120^\circ$ (d) $\tan 225^\circ$
(e) $\cos 240^\circ$ (f) $\sec 210^\circ$
(g) $\sin 315^\circ$ (h) $\sin 300^\circ$

4. Find the value of the following :-

- (a) $\sin\left(\frac{\pi}{6}\right)$ (b) $\cos\left(\frac{\pi}{4}\right)$
(c) $\tan\left(\frac{\pi}{3}\right)$ (d) $\cos\left(\frac{\pi}{2}\right)$
(e) $\cot\left(\frac{3\pi}{4}\right)$ (f) $\sin\left(\frac{5\pi}{6}\right)$
(g) $\sin \pi$ (h) $\cos \pi$
(i) $\sin\left(\frac{\pi}{2}\right)$ (j) $\sin\left(\frac{3\pi}{2}\right)$
(k) $\cos\left(\frac{3\pi}{2}\right)$

5. Find the values of the following :-

- (a) $\sin 390^\circ$ (b) $\cos 405^\circ$
(c) $\tan 420^\circ$ (d) $\cos 450^\circ$
(e) $\sin\left(2\pi + \frac{\pi}{6}\right)$ (f) $\cos\left(2\pi + \frac{\pi}{3}\right)$

6. Find the values of the following :-

- (a) $\sin(-30^\circ)$
(b) $\cos(-45^\circ)$
(c) $\sin(-60^\circ)$
(d) $\tan(-45^\circ)$

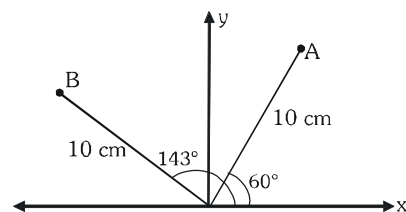
7. Find the values of all the other T-Ratios if :-

- (a) $\cos \theta = \frac{7}{25}$
(b) $\sin \theta = \frac{5}{13}$

8. Calculate the value of following :-

- (a) $\cos 75^\circ$
(b) $\sin 15^\circ$
(c) $\sin 75^\circ$
(d) $\cos 105^\circ$

9. Refer the given figure and identify correct statement(s)



- (1) Distance of A from x-axis is $5\sqrt{3}$ cm.
(2) Distance of B from x-axis is 6 cm.
(3) Distance of A from y-axis is 5 cm.
(4) Distance of B from y-axis is 8 cm.

10. **Statement 1** : For very small angle θ , we may use approximation $\sin\theta \approx \theta \approx \tan\theta$.

and

Statement 2 : For very small angle θ , the hypotenuse and the base become approximately of the same length.

- (1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1.
(3) Statement-1 is True, Statement-2 is False.
(4) Statement-1 is False, Statement-2 is True.

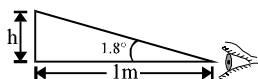
11. What is value of expression

$$2(\sin 15^\circ + \sin 75^\circ)^2 ?$$

12. Find the value of

$$5(\sin 100^\circ \cos 27^\circ + \sin 27^\circ \cos 100^\circ).$$

13. A normal human eye can see an object making an angle of 1.8° at the eye. What is the

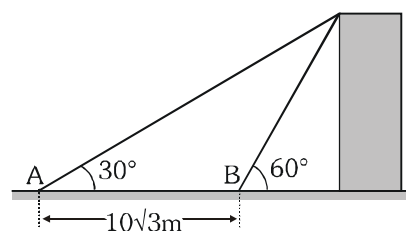


approximate height of object which can be seen by an eye placed at a distance of 1 m from the object.

14. The maximum and minimum values of expression $(4 - 2 \cos \theta)$ respectively are :-

- (1) 4 and 0 (2) 4 and 2
(3) 6 and 0 (4) 6 and 2

15. Angle of elevation is the angle which line of sight makes with the horizontal. Angle of elevation of the top of a tall building is 30° from a place A and becomes 60° from another place B that is $10\sqrt{3}$ m from A towards the building as shown in the figure. Height of the building is close to :-



- (1) 7.5 m (2) 10 m (3) 12.5 m (4) 15 m

16. If $\tan\theta = \frac{24}{7}$ and $\sin\theta$ is negative then value of $\cos\theta$ will be :-

- (1) $\frac{7}{25}$ (2) $-\frac{7}{25}$ (3) $\frac{24}{25}$ (4) $-\frac{24}{25}$

17. Suggest suitable match between function given in the first column and its description given in the second column.

Column-I

Column-II

- | | |
|------------------------|----------------------------------|
| (A) $\sin(390^\circ)$ | (P) Positive |
| (B) $\sin(-30^\circ)$ | (Q) Negative |
| (C) $\cos 120^\circ$ | (R) Zero |
| (D) $\tan(-120^\circ)$ | (S) Modulus is greater than one. |
| | (T) Modulus is less than one. |

18. Depending on in which quadrant an angle θ lies, functions $\cos\theta$ and $\sin\theta$ may be positive or negative. In the second column of the given table are specified whether these functions are positive or negative and in the first column are specified quadrants. Match column-I with column-II.

Column-I

Column-II

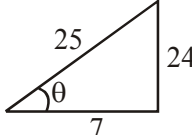
- | | |
|------------|---|
| (A) First | (P) $\sin\theta$ is positive |
| (B) Second | (Q) $\sin\theta$ is negative |
| (C) Third | (R) $\cos\theta$ is negative |
| (D) Fourth | (S) $\tan\theta$ and $\sin\theta$ both are negative |
| | (T) $\sec\theta$ is negative and $\sin\theta$ is positive |

19. An airplane takes off at an angle 30° with the horizontal ground traveling at the speed of 180 km/h. If it continues to fly with the same velocity in the same direction, how long will it take to reach an altitude of 9 km above the ground?

- (1) 5 minutes (2) 6 minutes
(3) 8 minutes (4) 9 minutes

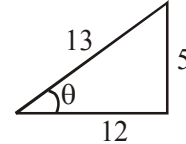
ANSWER KEY

1. (a) $\frac{\pi}{6}$ (b) $\frac{\pi}{4}$ (c) $\frac{\pi}{3}$
 (d) $\frac{\pi}{2}$ (e) $\frac{2\pi}{3}$ (f) $\frac{3\pi}{4}$
 (g) $\frac{7\pi}{6}$ (h) $\frac{3\pi}{2}$ (i) $\frac{7\pi}{4}$
2. (a) 45° (b) 30° (c) 60°
 (d) 135° (e) 210° (f) 225°
 (g) 450° (h) 315° (i) 300°
3. (a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$ (c) $-\frac{1}{2}$
 (d) 1 (e) $-\frac{1}{2}$ (f) $-\frac{2}{\sqrt{3}}$
 (g) $-\frac{1}{\sqrt{2}}$ (h) $-\frac{\sqrt{3}}{2}$
4. (a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$ (c) $\sqrt{3}$
 (d) 0 (e) -1 (f) $\frac{1}{2}$
 (g) 0 (h) -1 (i) 1
 (j) -1 (k) 0
5. (a) $\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$ (c) $\sqrt{3}$
 (d) 0 (e) $\frac{1}{2}$ (f) $\frac{1}{2}$
6. (a) $-\frac{1}{2}$ (b) $\frac{1}{\sqrt{2}}$
 (c) $-\frac{\sqrt{3}}{2}$ (d) -1

7. (a) $\cos\theta = \frac{7}{25}$
- 
- (1) $\sin\theta = \frac{24}{25}$ (4) $\operatorname{cosec}\theta = \frac{25}{24}$
 (2) $\cos\theta = \frac{7}{25}$ (5) $\sec\theta = \frac{25}{7}$

(3) $\tan\theta = \frac{24}{7}$ (6) $\cot\theta = \frac{7}{24}$

(b) $\sin\theta = \frac{5}{13}$



(1) $\sin\theta = \frac{5}{13}$ (4) $\operatorname{cosec}\theta = \frac{13}{5}$

(2) $\cos\theta = \frac{12}{13}$ (5) $\sec\theta = \frac{13}{12}$

(3) $\tan\theta = \frac{5}{12}$ (6) $\cot\theta = \frac{12}{5}$

8. (a) $\cos 75^\circ = \frac{\sqrt{3}-1}{2\sqrt{2}}$ (b) $\sin 15^\circ = \frac{\sqrt{3}-1}{2\sqrt{2}}$

(c) $\sin 75^\circ = \frac{\sqrt{3}+1}{2\sqrt{2}}$

(d) $\cos 105^\circ = -\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)$ or $\frac{1-\sqrt{3}}{2\sqrt{2}}$

9. (1,2,3,4) 10. (1)
 11. 3 12. 4 13. π cm
 14. (4) 15. (4) 16. (2)
 17. (A) $\rightarrow$ (P,T); (B) $\rightarrow$ (Q,T);
 (C) $\rightarrow$ (Q,T); (D) $\rightarrow$ (P,S)
 18. (A) $\rightarrow$ (P); (B) $\rightarrow$ (P,R,T);
 (C) $\rightarrow$ (Q,R); (D) $\rightarrow$ (Q,S)
 19. (2)

Basic Maths (Differentiation)

RACE # 02

1. For a straight line $y = \frac{4}{3}x - 4$. Choose correct alternative(s)

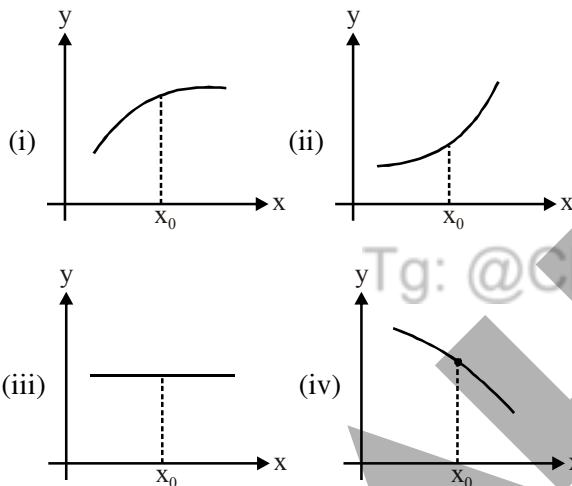
(1) $\frac{dy}{dx} = \tan 53^\circ$

(2) $\frac{dx}{dy} = \tan 37^\circ$

(3) x-intercept is 3

(4) length of line between x-axis and y-axis is 5 units

2. Which of the following statements are true based on graphs of y-versus x as shown below?



- (1) Slope at x_0 is positive and non-zero in graph (i) and (ii)
(2) Slope is constant in graph (iii)
(3) Slope at x_0 is negative in graph (iv)
(4) Slope at x_0 is negative in graph (ii)

3. Radius of a spherical balloon is increasing with respect to time at the rate of $2/\pi$ m/s. Find the rate of change in volume (in m^3/s) of the balloon when radius is 0.5 m ?

4. Given that $y = \sin 3x + \frac{4}{3}\cos 3x$. What is the maximum rate of change in y with respect to x ?

5. Find the first derivatives

(i) If $y = x^{-1/3}$, find $\frac{dy}{dx}$

(ii) If $x = t^6$, find $\frac{dx}{dt}$

(iii) If $z = u^3$, find $\frac{dz}{du}$

(iv) If $f = r^2 + r^{1/3}$, find $\frac{df}{dr}$

(v) If $x = 2t^3 - 3t^2 + 5t - 6$, find $\frac{dx}{dt}$

(vi) If $y = 3x^2$

(vii) If $y = x \ln x$

(viii) If $y = x \sin x$

(ix) If $y = \sin x \cos x$

(x) If $y = \sin^2 x + \cos^2 x$

(xi) If $y = \cos 2x$

(xii) If $v = \frac{4}{3}\pi r^3$, find $\frac{dv}{dr}$

(xiii) If $s = 4\pi r^2$, find $\frac{ds}{dr}$

6. Differentiation of $\cos(\sqrt{x})$ with respect to x is

(1) $-\sin \sqrt{x}$ (2) $-\frac{1}{2\sqrt{x}} \sin \sqrt{x}$

(3) $-\sqrt{x} \sin \sqrt{x}$ (4) $-\frac{1}{\sqrt{x}} \sin \sqrt{x}$

7. Given a function $y = x^2 - 2\sqrt{x}$. What is rate of change in y with respect to x when $x = 1$?

(1) Zero (2) 1 (3) 1.5 (4) -1.5

8. The height (in meters) at any time t (in seconds) of a ball thrown vertically varies according to equation $h(t) = -16t^2 + 256t$. How long after in seconds the ball reaches the highest point.

9. The slope of the tangent to the curve

$y = \ln(\cos x)$ at $x = \frac{3\pi}{4}$ is

(1) 1 (2) -1 (3) $\ln\sqrt{2}$ (4) $\frac{1}{\sqrt{2}}$

10. A stone is dropped into a quiet lake and waves move in circles spreading out radially at the speed of 0.5 m/s. At the instant when the radius of the circular wave is $\frac{4}{\pi}$ m, how fast is the enclosed area (in m^2/s) increasing?
11. The charge flowing through a conductor beginning with time $t=0$ is given by the formula $q=2t^2 + 3t + 1$ (coulombs). Find the current $i = \frac{dq}{dt}$ at the end of the 5th second.
12. Differentiate the following w.r.t. x
- (i) $y = x^2 + 5$ (ii) $y = 2e^3$
(iii) $y = (x + 5)^{-1/2}$ (iv) $y = 5x^{3/2}$
(v) $y = 4x^4 + 2x^3 + \frac{5}{x} + 9$
13. Calculate $\frac{dy}{dx}$ for the following :-
- (1) $y = \cos x^3$ (2) $y = \sin\left(\frac{x}{2}\right)$
(3) $y = \log_e 2x$ (4) $y = e^{-x}$
14. If $y = e^x \sin x$ then calculate $\frac{dy}{dx}$:-
15. Position of particle moving along x-axis is given as $x = 2 + 5t + 7t^2$ then calculate :
- (1) Velocity of particle $\left(i.e. \frac{dx}{dt}\right)$
(2) Initial velocity $\left(i.e. \frac{dx}{dt} \text{ at } t=0\right)$
(3) Velocity at $t = 2$ sec
(4) Acceleration of particle $\left(i.e. \frac{d^2x}{dt^2}\right)$
16. A metallic disc is being heated. Its area (in m^2) at any time t (in sec) is given by $A = 5t^2 + 4t$. Calculate the rate of increase in area at $t = 3$ sec.
17. If the velocity of a particle moving along x-axis is given as $v = (4t^2 + 3t + 1)$ m/s then what is the acceleration of the particle at $t = 1$ sec ?
18. A car moves along a straight line whose equation of motion is given by $s = 12t + 3t^2 - 2t^3$ where s is in metres and t is in seconds. The velocity of the car at start will be :-
- (1) 7 m/s (2) 9 m/s
(3) 12 m/s (4) 16 m/s
19. A particle moves along the x-axis such that its co-ordinate (x) varies with time (t), according to the expression : $x = 2 - 5t + 6t^2$, where x is in metres and t is in seconds. The initial velocity of the particle is :-
- (1) -5 m/s (2) -3 m/s
(3) 6 m/s (4) 2 m/s
20. Relation between displacement x and time t is $x = 2 - 5t + 6t^2$, the initial acceleration will be :-
- (1) -3 ms^{-2} (2) 12 ms^{-2}
(3) 2 ms^{-2} (4) -5 ms^{-2}
21. If $v = (t + 2)(t + 3)$ then acceleration $\left(i.e. \frac{dv}{dt}\right)$ at $t = 1$ sec :-
- (1) 5 m/s^2 (2) 7 m/s^2
(3) 2 m/s^2 (4) None of these
22. If $y = \log_e x + \sin x + e^x$ then $\frac{dy}{dx}$ is :-
- (1) $\frac{1}{x} + \sin x + e^x$ (2) $\frac{1}{x} - \cos x + e^x$
(3) $\frac{1}{x} + \cos x + e^x$ (4) $\frac{1}{x} - \sin x$

23. $\frac{d}{dx}(e^{100}) = \dots\dots\dots$
 (1) e^{100} (2) 0
 (3) $100e^{99}$ (4) None of these
24. $\frac{d}{dx}(\sin 120^\circ) = \dots\dots\dots$
 (1) $\cos 120^\circ$ (2) $120 \cos 120^\circ$
 (3) 0 (4) None of these
25. If $y = x^3 \cos x$ then $\frac{dy}{dx} = \dots\dots\dots$
 (1) $x^2(3 \cos x - x \sin x)$ (2) $x^2(3 \cos x + x \sin x)$
 (3) $3x^2 \cdot \cos x + x^3 \sin x$ (4) None of these
26. If $v = (t^2 - 4t + 10^5) \text{ m/s}$ where t is in second. Find acceleration at $t = 1$ sec.
 (1) 0 (2) 2 m/s^2
 (3) -2 m/s^2 (4) None of these
27. If $y = \sin x + \cos x$ then $\frac{d^2y}{dx^2}$ is :-
 (1) $\sin x - \cos x$ (2) $\cos x - \sin x$
 (3) $-(\sin x + \cos x)$ (4) None of these
28. The radius of spherical bubble is changing with time. Then rate of change of its volume is given by :
 (1) $4\pi r^2 \frac{dr}{dt}$ (2) $\frac{4}{3} \pi r^2$
 (3) $\frac{8}{3} \pi r^2$ (4) $\frac{8}{3} \pi r \frac{dr}{dt}$
29. Given that $y = \frac{10}{\sin x + \sqrt{3} \cos x}$. Minimum value of y is :-
 (1) zero (2) 2
 (3) 5 (4) $10/(1+\sqrt{3})$

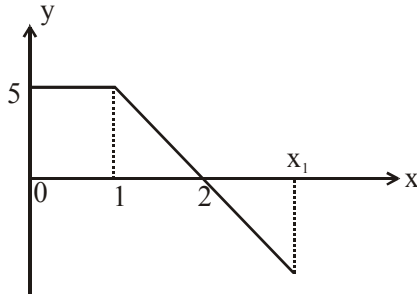
ANSWER KEY

1. (1,2,3,4) 2. (1,2,3) 3. $2 \text{ m}^3/\text{s}$ 4. 5
5. (i) $-\frac{1}{3}x^{-4/3}$ (ii) $6t^5$ (iii) $3u^2$ (iv) $2r + \frac{1}{3}r^{-2/3}$ (v) $6t^2 - 6t + 5$ (vi) $6x$ (vii) $1 + \ln x$
 (viii) $x \cos x + \sin x$ (ix) $\cos^2 x - \sin^2 x$ (x) 0 (xi) $-2 \sin 2x$ (xii) $4\pi r^2$ (xiii) $8\pi r$
6. (2) 7. (2) 8. 8 sec 9. (1) 10. $4 \frac{\text{m}^2}{\text{s}}$ 11. 23 Amp.
12. (i) $2x$ (ii) 0 (iii) $-\frac{1}{2}(x+5)^{-3/2}$ (iv) $\frac{15}{2}x^{1/2} = \frac{15}{2}\sqrt{x}$ (v) $16x^3 + 6x^2 - \frac{5}{x^2}$
13. (i) $-3x^2 \sin x^3$ (ii) $\frac{1}{2} \cos\left(\frac{x}{2}\right)$ (iii) $\frac{1}{x}$ (iv) $-e^{-x}$
14. $e^x(\sin x + \cos x)$
15. (i) $5 + 14t$ (ii) 5 (iii) 33 (iv) 14
16. $34 \text{ m}^2/\text{sec}$ 17. 11 m/sec^2 18. (3) 19. (1) 20. (2) 21. (2)
22. (3) 23. (2) 24. (3) 25. (1) 26. (3) 27. (3)
28. (1) 29. (3)

Basic Maths (Integration)

RACE # 03

1. Find the value of x_1 so that $\int_0^{x_1} y \, dx = 5$



2. Evaluate the following indefinite integrals.

(a) $\int \frac{dx}{\sqrt{x}}$

(b) $\int \frac{dx}{(2x+3)}$

(c) $\int \sin x \cos x \, dx$

3. Evaluate the following definite integrals.

(a) $\int_0^3 (x^2 + 1) \, dx$

(b) $\int_2^3 (x^3 - 4x^2 + 5x - 10) \, dx$

(c) $\int_0^{\pi/4} (\cos x - \sin x) \, dx$

4. Integrate the following

(1) $\int x^{-3/2} \, dx$

(2) $\int \sin 60^\circ \, dx$

(3) $\int \frac{1}{10x} \, dx$

(4) $\int (2x^3 - x^2 + 1) \, dx$

5. Value of $\int_0^2 3x^2 \, dx + \int_0^{\pi/2} \sin x \, dx$ is

6. If the velocity of a particle moving along x-axis is given as $v = (3t^2 - 2t)$ and at $t = 0$, $x = 0$ then calculate position of the particle at $t = 2$ sec.

(Hint :- change in position $\Delta x = \int v \, dt$)

7. Integrate the following :

(i) $\int \left(t - \frac{1}{t} \right)^2 \, dt$

(ii) $\int \sin(10t - 50) \, dt$

(iii) $\int e^{(100t+6)} \, dt$

8. An object initially at rest moves along x-axis subjected to an acceleration which varies with time according to relation $a = 2t + 5$. Its velocity after 2 seconds will be :-

- (1) $18 \, \text{ms}^{-1}$
(2) $9 \, \text{ms}^{-1}$
(3) $12 \, \text{ms}^{-1}$
(4) $14 \, \text{ms}^{-1}$

9. The value of integral $\int_2^4 \frac{dx}{x}$ is :-

- (1) $3 \log_e 2$ (2) $\log_e 2$
(3) $\log_e 4$ (4) $2 \log_e 8$

10. Area bounded by curve $y = \sin x$, with x-axis,

when x varies from 0 to $\frac{\pi}{2}$ is :-

- (1) 1 unit (2) 2 units
(3) 3 units (4) 0

ANSWER KEY

1. (3)

2. (a) $2\sqrt{x} + C$ (b) $\frac{1}{2} \ln(2x+3) + C$ (c) $-\frac{1}{4} \cos 2x + C$

3. (a) 12 (b) $-\frac{79}{12}$ (c) $\sqrt{2} - 1$

4. (i) $-2x^{-1/2} + C$ (ii) $\frac{\sqrt{3}}{2} x + C$ (iii) $\frac{1}{10} \log x + C$ (iv) $\frac{x^4}{2} - \frac{x^3}{3} + x + C$

5. (9) 6. $x = 4$ 7. (i) $\frac{t^3}{3} - \frac{1}{t} - 2t + C$ (ii) $\frac{-\cos(10t - 50)}{10} + C$ (iii) $\frac{1}{100} e^{100t+6} + C$

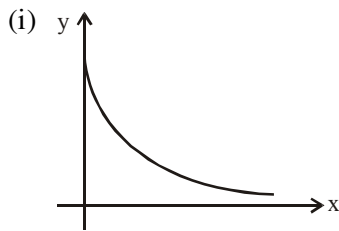
8. (4) 9. (2) 10. (1)

Tg: @Chalnaayaaar

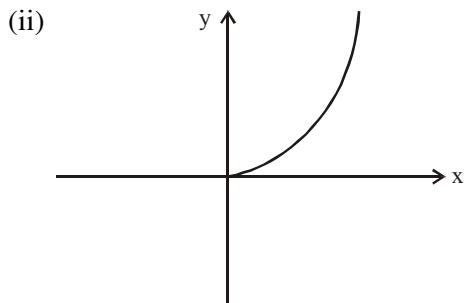
Basic Maths (Graphs)

RACE # 04

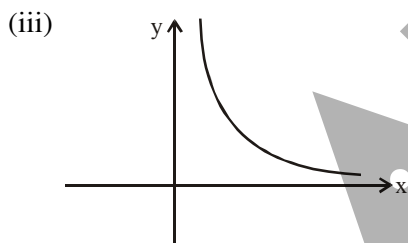
1. Which of the following equation is the best representation of the given graph's ?



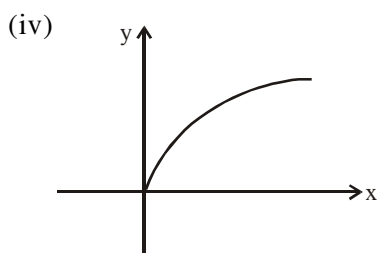
- (1) $y = \frac{2}{x}$ (2) $y = e^{-x}$
(3) $y = \frac{1}{x^2}$ (4) $y = x^2$



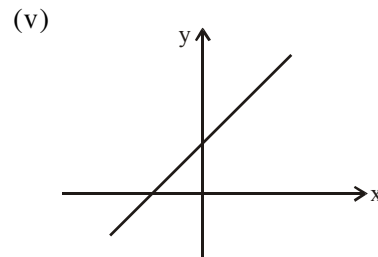
- (1) $y = x^2$ (2) $x = y^2$
(3) $y = e^x$ (4) $y = x$



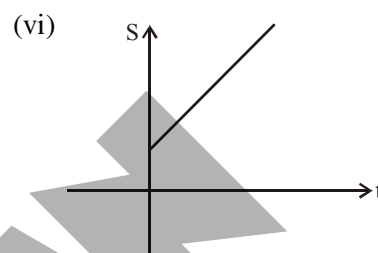
- (1) $y = e^{-x}$ (2) $y = e^x$
(3) $y = \frac{1}{x}$ (4) None of these



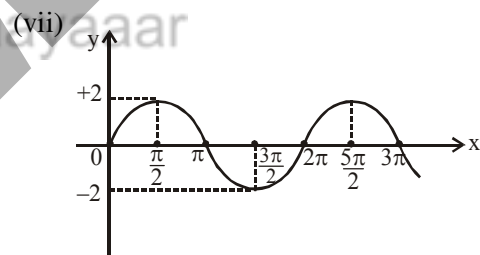
- (1) $y = 2x^2$ (2) $x = 2y^2$
(3) $y = -2x^2$ (4) $x = -2y^2$



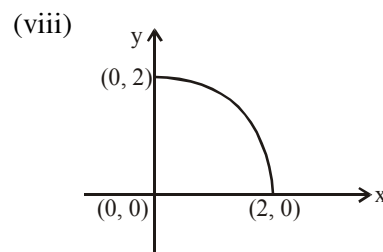
- (1) $y = x + 1$ (2) $y = 2x - 1$
(3) $y = -x - 1$ (4) $y = -2x + 3$



- (1) $S = 2t - 3$ (2) $S = 2t + 3$
(3) $S = 2t$ (4) None of these



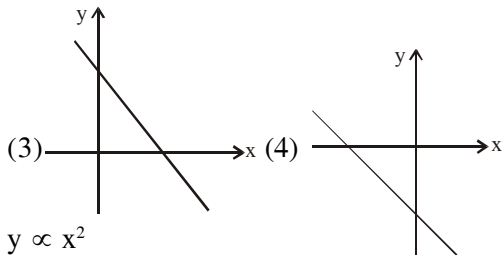
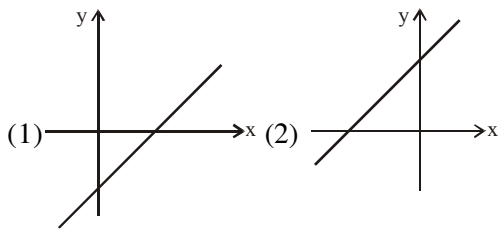
- (1) $y = 2\sin x$ (2) $y = 2\cos x$
(3) $y = \sin 2x$ (4) $y = \cos 2x$



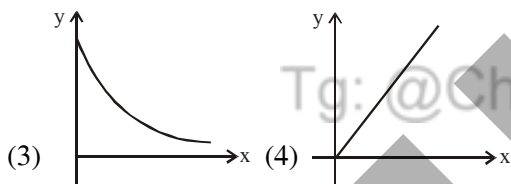
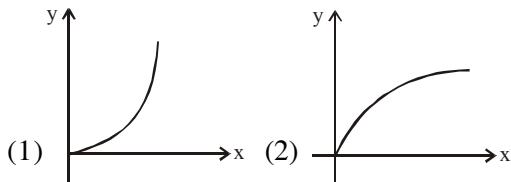
- (1) $x + y = 2$ (2) $x^2 + y^2 = 4$
(3) $x^2 + y^2 = 2$ (4) $x^2 + y = 2$

2. Which of two following graph is the best representation for the given equation.

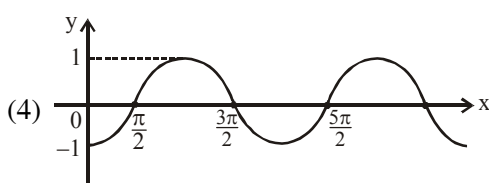
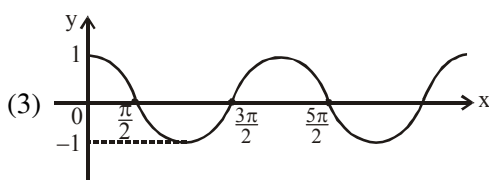
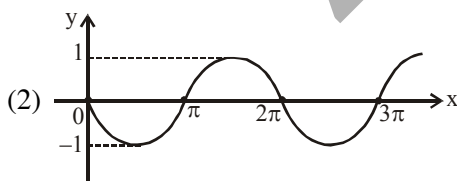
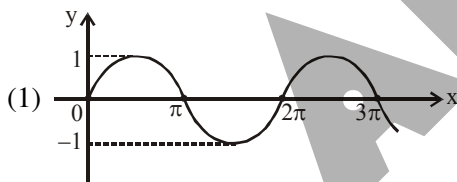
(i) $y = 2x - 1$



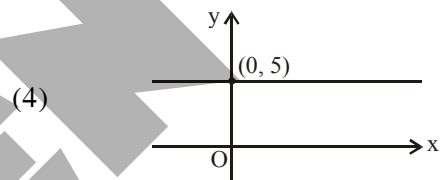
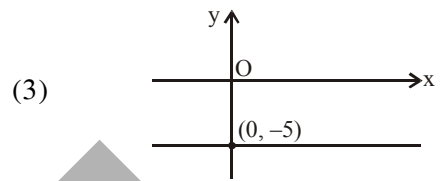
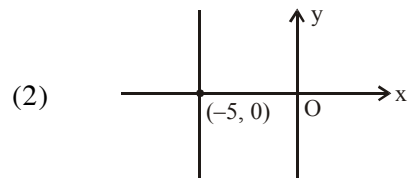
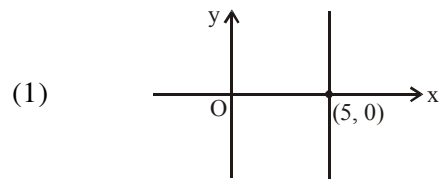
(ii) $y \propto x^2$



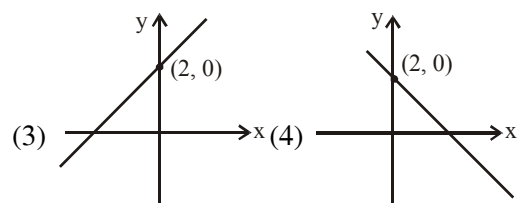
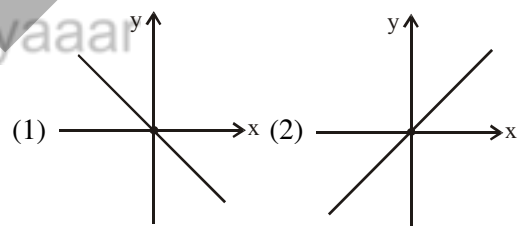
(iii) $y = \sin x$



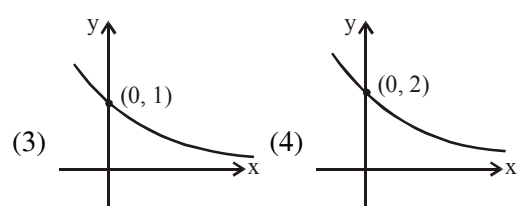
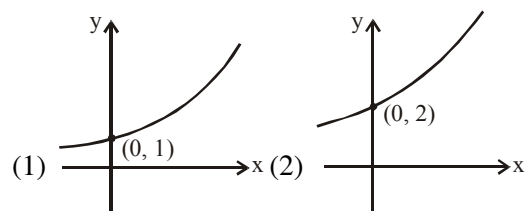
(iv) $y = 5$



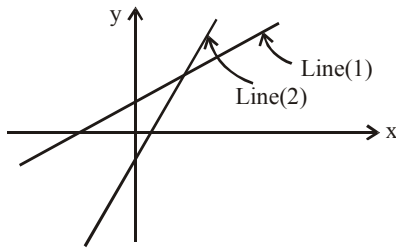
(v) $y = 2x$



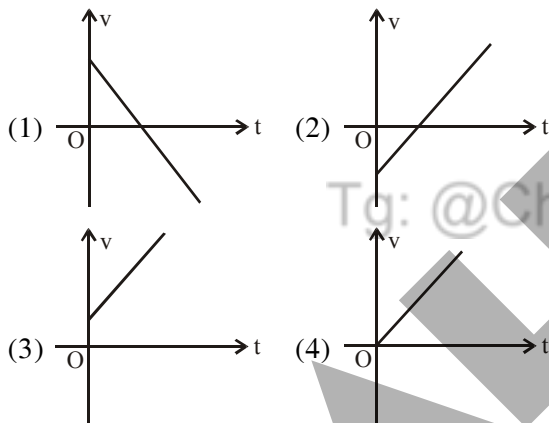
(vi) $y = 2e^x$



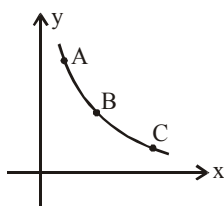
3. Which of the following statement is not correct for following straight line graph :-



- (1) Line (2) has negative y intercept
(2) Line (1) has positive y intercept
(3) Line (2) has positive slope
(4) Line (1) has negative slope
4. If velocity v varies with time(t) as $v = 2t - 3$, then the plot between v and t is best represented by :

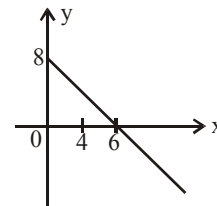


5. The slope of graph in figure at point A, B and C is m_A , m_B and m_C respectively, then :-

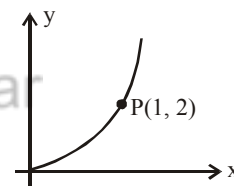


- (1) $m_A > m_B > m_C$ (2) $m_A < m_B < m_C$
(3) $m_A = m_B = m_C$ (4) $m_A = m_C < m_B$
6. The slope of straight line $\sqrt{3}y = 3x + 4$ is :-
- (1) 3 (2) $\sqrt{3}$
(3) $\frac{1}{\sqrt{3}}$ (4) $\frac{1}{3}$

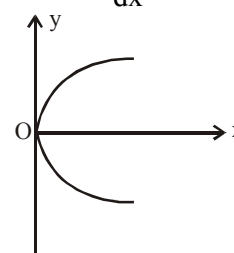
7. The equation of straight line shown in figure is :-



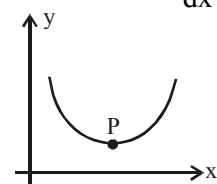
- (1) $6x + 8y = 15$
(2) $4x + 3y = 18$
(3) $2y + 6x = 7$
(4) $3y + 4x = 24$
8. The equation $\sqrt{x} = 2y$, represents that graph between x and y is a :-
- (1) Straight line (2) Parabola
(3) Hyperbola (4) Circle
9. The equation of graph shown in figure is $y = 2x^2$. The slope of graph at point P is :-



- (1) 1 (2) 2 (3) 3 (4) 4
10. At $x = 0$, value of $\frac{dy}{dx}$ is :-

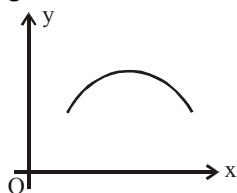


- (1) 0 (2) 1
(3) -1 (4) Infinite
11. At point P, the value of $\frac{dy}{dx}$ is :-



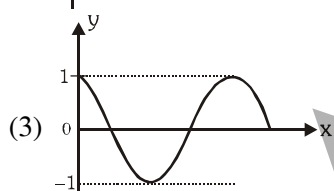
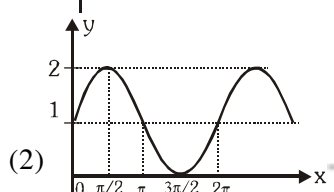
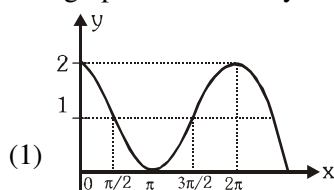
- (1) Zero (2) Positive
(3) Negative (4) Infinite

12. Magnitude of slope i.e. steepness of graph shown in figure



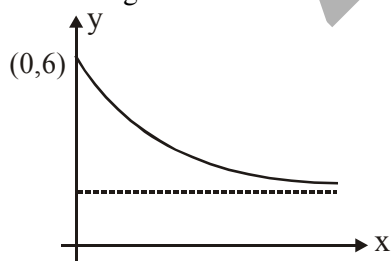
- (1) First increases and then decreases
- (2) First decreases and then increases
- (3) Decreases continuously
- (4) Increases continuously

13. The graph of function $y = 1 + \cos x$ will be :-

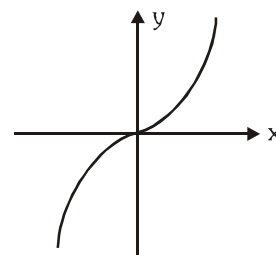


- (4) None of these

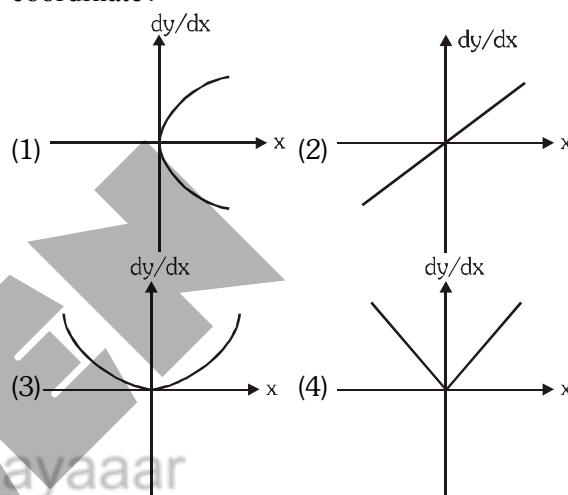
14. Graph of an exponential function $y = 2 + ae^{-x}$ is shown in figure. What is the value of a ?



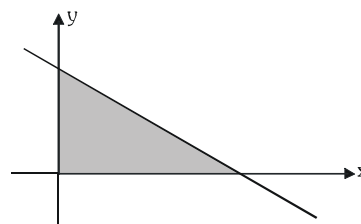
15. Figure shows the graph of the curve $y = \frac{1}{3}x^3$. Which of the following shows



the variation of slope of the curve with x coordinate?



16. In the given figure intercept on the positive y -axis made by straight line is 6 units and area enclosed by the line and both the axes is 72 square units. This area is shown by shaded portion in the figure. If both the axes have identical scale, equation of the line is :-



- (1) $y = -\frac{1}{24}x + 6$
- (2) $y = -\frac{1}{2}x + 6$
- (3) $y = -\frac{1}{3}x + 6$
- (4) $y = -\frac{1}{4}x + 6$

ANSWER KEY

- | | | | | | | | |
|----------|---------|---------|--------|---------|---------|---------|----------|
| 1. (i) 2 | (ii) 1 | (iii) 3 | (iv) 2 | (v) 1 | (vi) 2 | (vii) 1 | (viii) 2 |
| 2. (i) 1 | (ii) 1 | (iii) 1 | (iv) 4 | (v) 2 | (vi) 2 | | |
| 3. (4) | 4. (2) | 5. (2) | 6. (2) | 7. (4) | 8. (2) | 9. (4) | 10. (4) |
| 11. (1) | 12. (2) | 13. (1) | 14. 4 | 15. (3) | 16. (4) | | |

1. Find the value of :-

(i) $\sqrt{4}$ (ii) $\sqrt{9}$ (iii) $\sqrt{16}$ (iv) $\sqrt{36}$

2. Find the value of :-

(i) $\frac{1}{\sqrt{4}}$ (ii) $\frac{1}{\sqrt{16}}$ (iii) $\frac{1}{\sqrt{64}}$

3. If $2x^2 + 5x - 12 = 0$, find values of x.

4. If $10a^2 - 27a + 5 = 0$, find values of a

5. If $y^2 - 2y - 3 = 0$, find values of y.

6. Find the values of :-

(1) $(8)^{1/3}$ (2) $(64)^{1/2}$
(3) $4^{5/2}$ (4) $(36)^{3/2}$
(5) $(27)^{2/3}$

7. Find the values of :-

(i) 2^4 (ii) 4^3
(iii) 3^2 (iv) 5^3
(v) 9^4 (vi) 7^3

8. Solve the following :-

(i) $2 + 4 - 9$ (ii) $3 + 6 - 10$
(iii) $12 - 5 - 3$ (iv) $100 - 50 + 40$
(v) $5^3 - 3^4 - 2^2$ (vi) $6^4 + 2^2 - 8^3$

9. Simplify :-

(i) $\frac{10}{4}$ (ii) $\frac{200}{50}$ (iii) $\frac{27}{24}$
(iv) $\frac{55}{22}$ (v) $\frac{64}{16}$ (vi) $\frac{8}{6}$

10. Simplify :-

(i) $\frac{2}{\sqrt{2}}$ (ii) $\frac{\sqrt{3}}{3}$ (iii) $\sqrt{\frac{3}{4}}$
(iv) $\frac{6}{\sqrt{2}}$ (v) $\frac{\sqrt{5}}{10}$ (vi) $\sqrt{\frac{16}{2}}$

11. Solve the following :-

(i) $\sqrt{\frac{2}{3}} \times \sqrt{\frac{9}{2}}$ (ii) $\sqrt{\frac{5}{6}} \times \sqrt{\frac{3}{5}}$
(iii) $\sqrt{\frac{3}{5}} \div \sqrt{\frac{27}{125}}$ (iv) $\sqrt{\frac{4}{9}} \div \sqrt{\frac{64}{81}}$

12. Solve the following :-

(i) $2 \times 4 \times 5$

(ii) $9 \times 3 \times 4$

(iii) $6 \times \frac{1}{5} \times 125$

(iv) $15 \times 6 \times \frac{1}{10}$

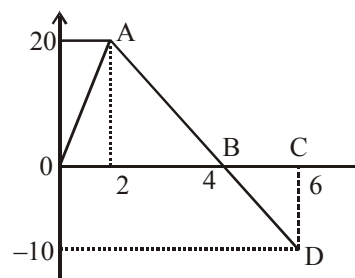
(v) $3 \times 4 \times \frac{1}{16} \times 15$

(vi) $20 \times 10 \times \frac{1}{500}$

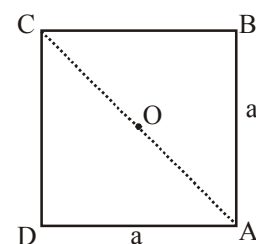
13. If $a = 10$, $b = 4$, $c = 6$, $d = 9$, find :-

(i) $\frac{ad}{bc}$ (ii) $ad \times bc$

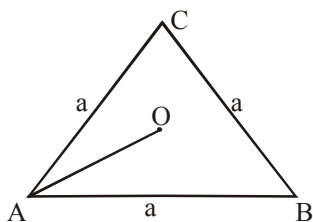
14. Find out area of triangle OAB and BCD shown in figure :-



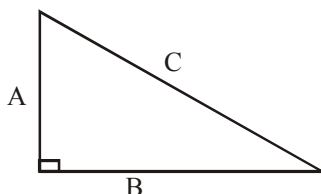
15. What is the distance OA for the square shown in figure :-



16. Find out length OA (O → centroid) and each interior angle of $\triangle ABC$ shown in figure :-



17. For the right angled triangle shown in figure, solve the following :-



- (i) If $A = 3$, $B = 4$, $C = ?$
- (ii) If $A = 6$, $C = 10$, $B = ?$
- (iii) If $C = 13$, $B = 12$, $A = ?$
- (iv) If $A = 5$, $B = 5$, $C = ?$
- (v) If $A = 4$, $B = 6$, $C = ?$

18. Given $KE = \frac{1}{2}mv^2$. If $m = 10\text{kg}$, $v = 5\text{m/s}$ then find the value of KE ?

19. Calculate the value of x in the following equation:-

- (i) $x^2 - 5x + 6 = 0$ (ii) $x^2 - 9x + 20 = 0$
- (iii) $x^2 - 15x + 56 = 0$ (iv) $x^2 - 16x + 63 = 0$

20. x-y relation is given by $y = x^n$. Calculate the value of n in the following :-

- (i) $y = \frac{x^2}{x^{2/3}}$ (ii) $y = \frac{x^{3/2}}{x^1}$
- (iii) $y = \frac{x^{1/2}}{x^{-1/2}}$ (iv) $y = \frac{x^{3/2}}{\sqrt{x}}$

21. $4\sqrt{6} \times 3\sqrt{24} = ?$

- (1) 124 (2) 134 (3) 144 (4) 154

22. A room is 12m long, 4m wide and 3m high, what will be the length of the longest bar that can be placed in the room :-

- (1) 12m (2) 5m (3) 19m (4) 13m

23. $\sqrt[3]{8^2}$ is equal to :-

- (1) $8^{4/3}$ (2) $8^{3/2}$ (3) $4^{2/3}$ (4) 4

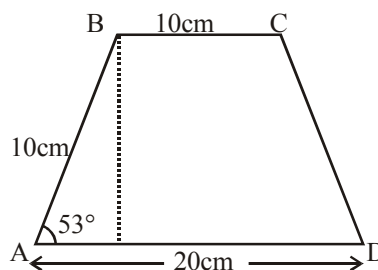
24. $\sqrt[5]{16} \times \sqrt[5]{2}$ is equal to :-

- (1) 2^2 (2) 2 (3) $2^{1/3}$ (4) $2^{2/3}$

25. If $x = \sqrt{2} - 1$ then find the value of $\left(\frac{1}{x} - x\right)^3$:-

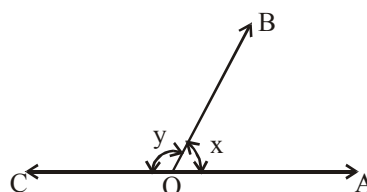
- (1) $2\sqrt{2} + 1$ (2) $2\sqrt{2} - 4$
- (3) 8 (4) 27

26. Find the area of shown trapezium :-



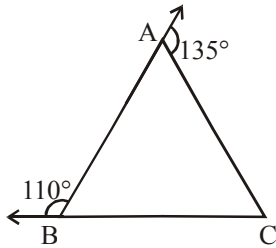
- (1) 60 cm^2 (2) 120 cm^2
- (3) 240 cm^2 (4) 360 cm^2

27. If $y - x = 80^\circ$ then find the values of x and y.



- (1) $50^\circ, 130^\circ$ (2) $60^\circ, 120^\circ$
- (3) $70^\circ, 110^\circ$ (4) $80^\circ, 100^\circ$

28. For shown situation find $\angle BCA$:-



- (1) 135° (2) 110°
(3) 75° (4) 65°

29. A cube of 2 cm edge is cut off into 8 cubes of 1 cm edge. What is their total surface area ?

- (1) 8 cm^2 (2) 16 cm^2
(3) 24 cm^2 (4) 48 cm^2

30. How many solid spherical balls of radius 2cm can be casted (made) by melting a solid sphere of radius 8cm :-

- (1) 4 (2) 16 (3) 32 (4) 64

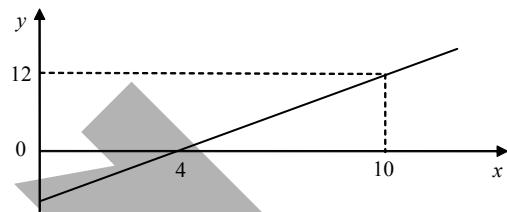
31. A function has the form $f(x)=ax+b$, where a and b are constants. If $f(2)=1$ and $f(-3)=11$, the function is defined by :-

- (1) $f(x)=2x+5$ (2) $f(x)=2x-5$
(3) $f(x)=-2x+5$ (4) $f(x)=-2x-5$

32. Use the approximation $(1+x)^n \approx 1+nx, |x| \ll 1$, to find approximate value for :-

- (a) $\sqrt{99}$ (b) $\frac{1}{1.01}$

33. In the following graph, relation between two variables x and y is shown by a straight line.



Equation of the straight line is :-

- (1) $y=1.2x+4$ (2) $y=1.2x-4$
(3) $y=2x-8$ (4) $y=2x+8$

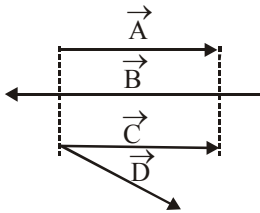
ANSWER KEY

1. (i) 2 (ii) 3 (iii) 4 (iv) 6 2. (i) $\frac{1}{2} = 0.5$ (ii) $\frac{1}{4} = 0.25$ (iii) $\frac{1}{8} = 0.125$
3. -4 or $\frac{3}{2}$ 4. $\frac{5}{2}$ or $\frac{1}{5}$ 5. 3 or -1 6. (i) 2 (ii) 8 (iii) 32 (iv) 216 (v) 9
7. (i) 16 (ii) 64 (iii) 9 (iv) 125 (v) 6561 (vi) 343 8. (i) -3 (ii) -1 (iii) 4 (iv) 90 (v) 40 (vi) 788
9. (i) $\frac{5}{2}$ (ii) 4 (iii) $\frac{9}{8}$ (iv) $\frac{5}{2}$ (v) 4 (vi) $\frac{4}{3}$
10. (i) $\sqrt{2}$ (ii) $\frac{1}{\sqrt{3}}$ (iii) $\frac{\sqrt{3}}{2}$ (iv) $3\sqrt{2}$ (v) $\frac{1}{2\sqrt{5}}$ (vi) $2\sqrt{2}$
11. (i) $\sqrt{3}$ (ii) $\frac{1}{\sqrt{2}}$ (iii) $\frac{5}{3}$ (iv) $\frac{3}{4}$ 12. (i) 40 (ii) 108 (iii) 150 (iv) 9 (v) 11.25 (vi) 0.4
13. (i) $\frac{15}{4}$ (ii) 2160 14. 40, -10 15. $\frac{a}{\sqrt{2}}$ 16. $\frac{a}{\sqrt{3}}$, 60° (each)
17. (i) 5 (ii) 8 (iii) 5 (iv) $5\sqrt{2}$ (v) $2\sqrt{13}$ 18. 125 J
19. (i) 2,3 (ii) 4,5 (iii) 7,8 (iv) 7,9 20. (i) $\frac{4}{3}$ (ii) $\frac{1}{2}$ (iii) 1 (iv) 1
21. (3) 22. (4) 23. (4) 24. (2) 25. (3) 26. (2) 27. (1)
28. (4) 29. (4) 30. (4) 31. (3) 32. (a) 9.95, (b) 0.99 33. (3)

VECTORS

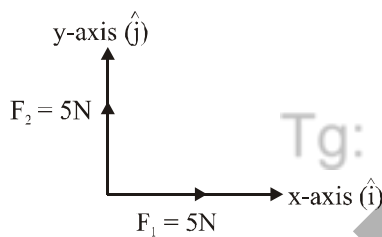
RACE # 01

1. State true or false for the given vectors



- (1) $\vec{A}$ and $\vec{B}$ are opposite vectors.
- (2) $\vec{A}$ and $\vec{C}$ are equal as well as parallel.
- (3) $\vec{A}$, $\vec{C}$ and $\vec{D}$ are coplanar vectors
- (4) $\vec{B}$, $\vec{C}$ and $\vec{D}$ are coplanar vectors
- (5) $\vec{C}$ and $\vec{D}$ are coinitial vectors

2. For the given two forces $\vec{F}_1$ & $\vec{F}_2$, state true or false



means $\vec{F}_1 = 5N\hat{i}$

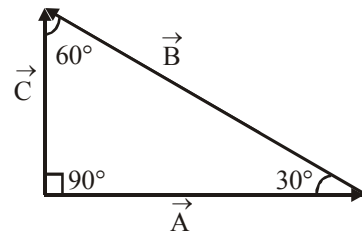
$\vec{F}_2 = 5N\hat{j}$

- (1) $\vec{F}_1 = \vec{F}_2$
- (2) $|\vec{F}_1| = |\vec{F}_2|$
- (3) $F_1 = F_2$
- (4) $\vec{F}_1 \perp \vec{F}_2$
- (5) $\hat{F}_1 = \hat{F}_2$
- (6) $\hat{F}_1 \perp \hat{F}_2$
- (7) $|\hat{F}_1| = |\hat{F}_2|$

3. State whether the following relations are true or false :-

- (1) $\vec{AB} = \vec{BA}$
- (2) $\vec{AB} = -\vec{BA}$
- (3) $|\vec{AB}| = |\vec{BA}|$
- (4) $|\vec{AB}| = |-\vec{AB}|$
- (5) $\hat{j} = \hat{k}$
- (6) $|\hat{j}| = |\hat{k}|$

4. For the given vector triangle find the following angle ?



- (1) Angle between $\vec{A}$ and $\vec{B}$ =
- (2) Angle between $\vec{B}$ and $\vec{C}$ =
- (3) Angle between $\vec{A}$ and $\vec{C}$ =

5. State whether the following statements are true or false :-

(1) Magnitude of $\vec{P}$ can be -5 unit.

(2) $|\hat{N}| = 1$

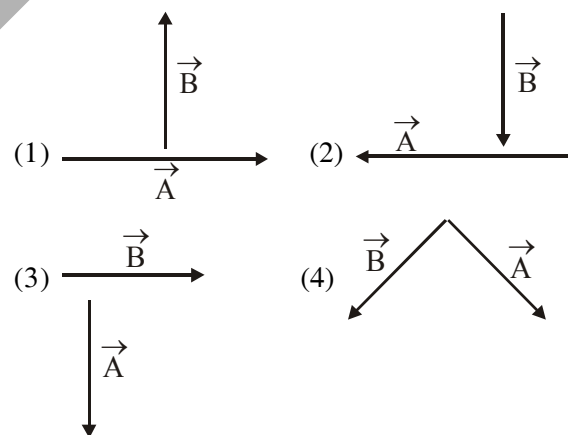
(3) Magnitude of any vector is a scalar.

(4) Unit vectors of parallel vectors are equal.

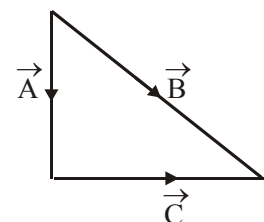
6. The magnitude of a vector cannot be :-

(1) positive (2) unity (3) negative (4) zero

7. Add vectors $\vec{A}$ & $\vec{B}$ by triangle law in the following cases :



8. For the given vectors, which of the following option is correct :



- (1) $\vec{A} + \vec{B} = \vec{C}$
- (2) $\vec{A} + \vec{C} = \vec{B}$
- (3) $\vec{B} + \vec{C} = \vec{A}$
- (4) None of these

Note : The resultant of 3 vectors $\vec{A}$, $\vec{B}$ and $\vec{C}$ can be zero if they satisfy the following condition.

$$(\vec{A} \sim \vec{B}) \leq C \leq (\vec{A} + \vec{B})$$

9. Which of the following group of concurrent forces may be in equilibrium ($R = 0$)?

A B C

- (1) 10 20 40
(2) 3 5 1
(3) 20 20 20
(4) 40 30 5

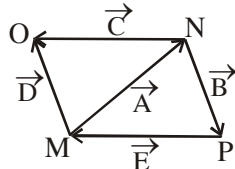
10. From the figure, the correct relation is -

(1) $\vec{A} + \vec{B} + \vec{E} = \vec{0}$

(2) $\vec{C} - \vec{D} = -\vec{A}$

(3) $\vec{B} + \vec{E} - \vec{C} = -\vec{D}$

(4) All of the above



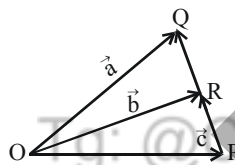
11. Figure shows three vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$. If $\vec{RQ} = 2\vec{PR}$, which of the following relation is correct :-

(1) $2\vec{a} + \vec{c} = 3\vec{b}$

(2) $\vec{a} + 3\vec{c} = 2\vec{b}$

(3) $3\vec{a} + \vec{c} = 2\vec{b}$

(4) $\vec{a} + 2\vec{c} = 3\vec{b}$



12. With respect to a rectangular cartesian coordinate system, three vectors are expressed as $\vec{a} = 4\hat{i} - \hat{j}$, $\vec{b} = -3\hat{i}$ and $\vec{c} = -\hat{k}$ where $\hat{i}, \hat{j}, \hat{k}$ are unit vectors of axis x, y and z then $\hat{r}$ along the direction of sum of these vector is :-

(1) $\hat{r} = \frac{1}{\sqrt{3}}(\hat{i} - \hat{j} - \hat{k})$

(2) $\hat{r} = \frac{1}{\sqrt{2}}(\hat{i} + \hat{j} - \hat{k})$

(3) $\hat{r} = \frac{1}{3}(\hat{i} - \hat{j} + \hat{k})$

(4) $\hat{r} = \frac{1}{\sqrt{2}}(\hat{i} + \hat{j} + \hat{k})$

13. Two forces of equal magnitude are acting at a point with an angle of 60° between them. If the resultant force is equal to $40\sqrt{3}\text{N}$, The magnitude of each force is :-

- (1) 40 N (2) 20 N (3) 80 N (4) 30 N

14. Two forces 3N and 2N are at an angle θ such that the resultant is R. The first force is now increased to 6N and the resultant become 2R. The value of θ is :-

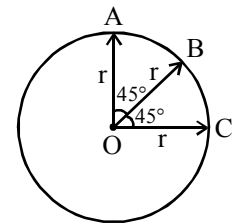
- (1) 30° (2) 60° (3) 90° (4) 120°

15. The resultant of the vectors $\vec{A}$ and $\vec{B}$ is perpendicular to the vector $\vec{A}$ and its magnitude is equal to half the magnitude of vector $\vec{B}$. The angle between $\vec{A}$ and $\vec{B}$ is :-

- (1) 120° (2) 150° (3) 135° (4) None of these

16. The resultant of the three vectors $\vec{OA}$, $\vec{OB}$ and $\vec{OC}$ shown in figure :-

- (1) r
(2) 2r
(3) $r(1 + \sqrt{2})$
(4) $r(\sqrt{2} - 1)$



17. If $\frac{|\vec{a} + \vec{b}|}{|\vec{a} - \vec{b}|} = 1$, then angle between $\vec{a}$ and $\vec{b}$ is :-

- (1) 0° (2) 45° (3) 90° (4) 60°

18. The magnitude of pairs of displacement vectors are given. Which pairs of displacement vectors cannot be added to give a resultant vector of magnitude 13 cm :-

- (i) 4 cm, 12 cm (ii) 4 cm, 8 cm
(iii) 6 cm, 8 cm (iv) 1 cm, 15 cm
(1) (ii, iv) (2) (i, ii)
(3) (i, iii) (4) (ii, iii)

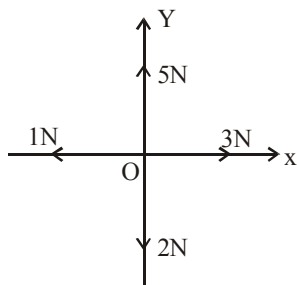
19. I started walking down a road to day-break facing the sun. After walking for some time, I turned to my left, then I turned to the right once again. In which direction was I going then :-

- (1) East (2) North-west
(3) North-east (4) South

20. $\vec{A}, \vec{B}$ and $\vec{C}$ are three orthogonal vectors with magnitudes 3, 4 and 12 respectively. The value of $|\vec{A} - \vec{B} + \vec{C}|$ will be :-

- (1) 11 (2) 19
(3) 13 (4) can't be determined

21. In the shown figure what amount of force and in which direction we should apply so that net force only acts along x-axis only :-



- (1) 3N along -ve of y-axis
(2) 3N along +ve of y-axis
(3) 2N along -ve of x-axis
(4) 2N along +ve of x-axis

22. Given $\vec{a} + \vec{b} = 2\hat{i}$, if $\vec{b} = 3\hat{j} - \hat{k}$ then find out vector $\vec{a}$:-

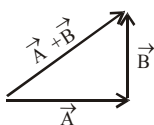
- (1) $2\hat{i} + 3\hat{j} + \hat{k}$ (2) $2\hat{i} - 3\hat{j} + \hat{k}$
(3) $\hat{j} + \hat{k}$ (4) $2\hat{i} - \hat{j} - \hat{k}$

ANSWER KEY

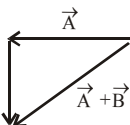
1. (i) False (ii) True (iii) True (iv) True (v) True
2. (i) False (ii) True (iii) True (iv) True (v) False (vi) True (vii) True
3. (i) False (ii) True (iii) True (iv) True (v) False (vi) True
4. (i) $180^\circ - 30^\circ = 150^\circ$ (ii) 60° (iii) 90°
5. (i) False (ii) True (iii) True (iv) True

6. 3

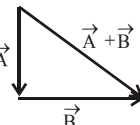
7. (i)



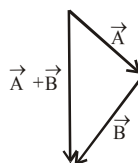
(ii)



(iii)



(iv)



8. 2

9. 3

10. 4

11. 4

12. 1

13. 1

14. 4

15. 2

16. 3

17. 3

18. 1

19. 1

20. 3

21. 1

22. 2

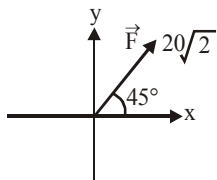
VECTORS

RACE # 02

1. Which of the following statement is true :-

- (1) When the coordinate axis are translated the component of vector in a plane changes
- (2) When the coordinate axis are rotated through some angle components of the vector change but the vector's magnitude remains constant.
- (3) Sum of $\vec{a}$ and $\vec{b}$ is $\vec{R}$. If the magnitude of $\vec{a}$ alone is increased angle between $\vec{b}$ and $\vec{R}$ decreases.
- (4) The cross product of $3\hat{i}$ and $4\hat{j}$ is 12.

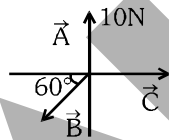
2. Write the vector $\vec{F}$ in terms of its component :-



- (1) $\vec{F} = 10\hat{i} + 10\hat{j}$
- (2) $\vec{F} = 20\hat{i} + 20\hat{j}$
- (3) $\vec{F} = 30\hat{i} + 30\hat{j}$
- (4) $\vec{F} = 40\hat{i} + 40\hat{j}$

3. If $\vec{A} + \vec{B} + \vec{C} = \vec{O}$

then $|\vec{B}|$ and $|\vec{C}|$ are :



- (1) 10N, 20N
- (2) $\frac{20}{\sqrt{3}}$ N, 10N
- (3) $\frac{20}{\sqrt{3}}$ N, $\frac{10}{\sqrt{3}}$ N
- (4) 20N, $\frac{10}{\sqrt{3}}$ N

4. A vector is represented by $3\hat{i} + \hat{j} + 2\hat{k}$, magnitude of its projection in XY plane is :-

- (1) 2
- (2) $\sqrt{14}$
- (3) $\sqrt{10}$
- (4) $\sqrt{5}$

5. Resultant of two forces $\vec{F}_1$ and $\vec{F}_2$ has magnitude 50 N. The resultant is inclined to $\vec{F}_1$ at 60° and to $\vec{F}_2$ at 30° . Magnitudes of $\vec{F}_1$ and $\vec{F}_2$ respectively are :-

- (1) 25 N, $25\sqrt{3}$ N
- (2) 20 N, $20\sqrt{3}$ N
- (3) 20 N, 30 N
- (4) 30 N, 40 N

6. Two force vectors each having magnitude 6N are oriented as 30° from positive of x-axis and other at 90° with the same axis. Find out the magnitude of their resultant and its angle with positive x axis :-

- (1) $6\sqrt{3}$ N, 30°
- (2) 6N, 60°
- (3) $6\sqrt{2}$ N, 60°
- (4) $6\sqrt{3}$ N, 60°

ANSWER KEY

1. 2 2. 2 3. 3 4. 3 5. 1 6. 4

VECTORS

RACE # 03

- If $\vec{P} = K\vec{Q}$ (Here K is constant) then :-
 (1) $\vec{P} \parallel \vec{Q}$ (2) $\vec{P} \nparallel \vec{Q}$
 (3) $\vec{P} \perp \vec{Q}$ (4) Both (1) and (2)
- The dot product of two vectors of magnitudes 3 units and 5 units cannot be :-
 (i) -20 (ii) 16 (iii) -10 (iv) 14
 (1) (i, iii) (2) (i, ii)
 (3) (i, iv) (4) (ii, iii, iv)
- If $\vec{A} = 2\hat{i} + 3\hat{j} - \hat{k}$ and $\vec{B} = -\hat{i} + 3\hat{j} + 4\hat{k}$, then projection of $\vec{A}$ on $\vec{B}$ is :-
 (1) $\frac{3}{\sqrt{13}}$ (2) $\frac{3}{\sqrt{26}}$ (3) $\sqrt{\frac{3}{26}}$ (4) $\sqrt{\frac{3}{13}}$
- If $|\hat{A} \times \hat{B}| = -\sqrt{3} \hat{A} \cdot \hat{B}$, then $|\hat{A} - \hat{B}| = \dots\dots\dots$
 (1) 0 (2) 1 (3) -1 (4) $\sqrt{3}$
- Find the torque of a force $\vec{F} = 2\hat{i} + \hat{j} + 4\hat{k}$ acting at the point $\vec{r} = 7\hat{i} + 3\hat{j} + \hat{k}$:
 (1) $14\hat{i} - 38\hat{j} + 16\hat{k}$ (2) $4\hat{i} + 4\hat{j} + 6\hat{k}$
 (3) $-14\hat{i} + 38\hat{j} - 16\hat{k}$ (4) $11\hat{i} - 26\hat{j} + \hat{k}$
- What is the value of linear velocity, if $\vec{\omega} = 3\hat{i} - 4\hat{j} + \hat{k}$ and $\vec{r} = 5\hat{i} - 6\hat{j} + 6\hat{k}$?
 (1) $4\hat{i} - 13\hat{j} + 6\hat{k}$ (2) $6\hat{i} - 2\hat{j} + 3\hat{k}$
 (3) $6\hat{i} - 2\hat{j} + 8\hat{k}$ (4) $-18\hat{i} - 13\hat{j} + 2\hat{k}$
- The angle made by the vector $\vec{A} = \hat{i} + \hat{j}$ with x-axis is
 (1) 90° (2) 45°
 (3) 22.5° (4) 30°
- Correct relation is :
 (1) $\hat{j} \times \hat{k} = \hat{i}$ (2) $\hat{i} \cdot \hat{i} = 0$
 (3) $\hat{j} \times \hat{j} = 1$ (4) $\hat{k} \cdot \hat{i} = 1$
- Two vectors $\vec{A} = 3\hat{i} + 2\hat{j} + \hat{k}$ and $\vec{B} = 5\hat{i} - 9\hat{j} + P\hat{k}$ are perpendicular to each other. The value of 'P' is :-
 (1) 3 (2) -3 (3) -2 (4) 2
- If the vectors $(\hat{i} + \hat{j} + \hat{k})$ and $3\hat{i}$ form two sides of a triangle, then area of the triangle is :
 (1) $\sqrt{3}$ unit (2) $2\sqrt{3}$ unit
 (3) $\frac{3}{\sqrt{2}}$ unit (4) $3\sqrt{2}$ unit
- The magnitude of projection of vector $3\hat{i} + 4\hat{k}$ on y-axis.
 (1) 5 (2) 4 (3) 3 (4) Zero
- Consider two vectors $\vec{F}_1 = 2\hat{i} + 5\hat{k}$ and $\vec{F}_2 = 3\hat{j} + 4\hat{k}$. The scalar product of these vectors is :-
 (1) 20 (2) 23 (3) $5\sqrt{33}$ (4) 26
- When $\vec{A} \cdot \vec{B} = -|\vec{A}||\vec{B}|$, then :-
 (1) $\vec{A}$ and $\vec{B}$ are perpendicular to each other
 (2) $\vec{A}$ and $\vec{B}$ act in the same direction
 (3) $\vec{A}$ and $\vec{B}$ act in the opposite direction
 (4) $\vec{A}$ and $\vec{B}$ can act in any direction
- $(\vec{A} + 2\vec{B}) \cdot (2\vec{A} - 3\vec{B})$:-
 (1) 0 (2) $2AB \cos \theta - 6B^2$
 (3) 8 (4) $2A^2 + AB \cos \theta - 6B^2$
- If $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = 6\hat{i} + 8\hat{j}$, select correct alternatives :-
 (i) $\vec{A} \cdot \vec{B} = 50$ (ii) $2A = B$
 (iii) $\hat{A} = \hat{B}$ (iv) $\hat{A} \times \vec{B} = \vec{0}$
 (1) (i, ii) (2) (ii, iii)
 (3) (i, iv) (4) (i, ii, iii, iv)
- The angle between the vectors $(\hat{i} + \hat{j})$ and $(\hat{j} + \hat{k})$ is :-
 (1) 90° (2) 180°
 (3) 0° (4) 60°

17. $\vec{A}$ and $\vec{B}$ are vectors expressed as $\vec{A} = 2\hat{i} + \hat{j}$ and $\vec{B} = \hat{i} - \hat{j}$ then unit vector perpendicular to $\vec{A}$ and $\vec{B}$ is :-

(1) $\frac{\hat{i} - \hat{j} + \hat{k}}{\sqrt{3}}$ (2) $\frac{\hat{i} + \hat{j} - \hat{k}}{\sqrt{3}}$ (3) $\frac{\hat{i} + \hat{j} + \hat{k}}{\sqrt{3}}$ (4) $\hat{k}$

18. The velocity of a particle is $\vec{v} = 6\hat{i} + 2\hat{j} - 2\hat{k}$. The component of the velocity of a particle parallel to vector $\vec{a} = \hat{i} + \hat{j} + \hat{k}$ in vector form is :-

(1) $6\hat{i} + 2\hat{j} + 2\hat{k}$ (2) $2\hat{i} + 2\hat{j} + 2\hat{k}$
(3) $\hat{i} + \hat{j} + \hat{k}$ (4) $6\hat{i} + 2\hat{j} - 2\hat{k}$

19. Two vectors $\vec{A} = 4\hat{i} + \alpha\hat{j} + 2\hat{k}$ and $\vec{B} = 2\hat{i} + \hat{j} + \hat{k}$ are parallel if :-

(1) $\alpha = 0$ (2) $\alpha = 1$ (3) $\alpha = 2$ (4) $\alpha = 4$

20. If $\vec{A} \times \vec{B} = \vec{C}$ then find out the correct one :-

(1) $\vec{A} \cdot \vec{B} = 0$ (2) $\vec{A} \cdot \vec{C} \neq 0$
(3) $\vec{B} \cdot \vec{C} \neq 0$ (4) $(\vec{A} + \vec{B}) \cdot \vec{C} = 0$

21. The position vectors of points A, B, C and D are $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$, $\vec{B} = 4\hat{i} + 5\hat{j} + 6\hat{k}$, $\vec{C} = 7\hat{i} + 9\hat{j} + 3\hat{k}$ and $\vec{D} = 4\hat{i} + 6\hat{j}$, then displacement vectors $\vec{AB}$ and $\vec{CD}$ are :-

(1) Same (2) Parallel
(3) Perpendicular (4) Antiparallel

ANSWER KEY

1. 4	2. 2	3. 2	4. 4	5. 4	6. 4	7. 2	8. 1	9. 1
10. 3	11. 4	12. 1	13. 3	14. 4	15. 4	16. 4	17. 4	18. 2
19. 3	20. 4	21. 4						

Units, Dimensions & Measurements

RACE # 01

- Which one of the following is not a fundamental quantity ?
(1) Temperature (2) Electric current
(3) Pressure (4) Length
- Which unit is used for measuring nuclear area of cross-section ?
(1) mm^2 (2) Fermi (3) Barn (4) Curie
- Which of the following is not correct representation of a unit ?
(1) Newton (2) Sec
(3) a.m.u. (4) All of these
- Which of the following is not a fundamental unit in SI system ?
(1) ampere (2) candela
(3) kelvin (4) Pascal
- Which one of the following is unitless quantity ?
(1) Velocity gradient
(2) Pressure gradient
(3) Displacement gradient
(4) Force gradient
- What can be the maximum distance of star which can be measured by using parallax method ?
(1) 1 parsec (2) 1 AU
(3) 100 ly (4) Infinite
- Two physical quantities A and B have different dimensions. Which mathematical operation given below is physically possible ?
(1) $\sqrt{AB}$ (2) $A(1+B)$
(3) $A-B$ (4) $A+B$
- Which of the following equations is dimensionally incorrect ?
(E = energy, U = potential energy, P = momentum, m = mass, v = speed)
(1) $E = U + \frac{P^2}{2m}$ (2) $E = mv^2 + \frac{P^2}{m}$
(3) $2E = \frac{U}{2} - \frac{1}{2}mv^2$ (4) $E = \frac{P^2U}{2mv^2}$
- 1 joule of energy is to be converted into new system of units in which length is measured in 10 metre, mass in 10 kg and time in 1 minute. The numerical value of 1 J in the new system is :
(1) 36×10^{-4} (2) 36×10^{-3}
(3) 36×10^{-2} (4) 36×10^{-1}
- The potential energy of a particle varies with distance x from a fixed origin as
 $U = \frac{A\sqrt{x}}{x^2 + B}$, where A and B are dimensional constants then dimensional formula for AB is :-
(1) $[ML^{7/2} T^{-2}]$ (2) $[ML^{11/2} T^{-2}]$
(3) $[M^2L^{9/2} T^{-2}]$ (4) $[ML^{13/2} T^{-3}]$
- Which of the following relation cannot be deduced using dimensional analysis ? [the symbols have their usual meanings]
(1) $y = A \sin(\omega t + kx)$ (2) $v = u + at$
(3) $k = \frac{1}{2}mv^2$ (4) All of these
- Of the following quantities which one has dimensions different from the remaining three ?
(1) Energy per unit volume
(2) Force per unit area
(3) Product of voltage and charge per unit volume
(4) Angular momentum per unit mass
- If momentum (P), area (A) and time (T) are taken to be fundamental quantities, then energy has the dimensional formula :
(1) $[P^1A^{-1}T^1]$ (2) $[P^2A^1T^1]$
(3) $[P^1A^{-1/2}T^1]$ (4) $[P^1A^{1/2}T^{-1}]$
- Which of the following specification is most accurate ?
(1) $63.1 \times 10^2 \text{ m}$
(2) $6.31 \times 10^3 \text{ m}$
(3) 6310 m
(4) $0.0631 \times 10^5 \text{ m}$
- If $a = 8 \pm 0.08$ and $b = 6 \pm 0.06$, Let $x = a + b$, $y = a - b$, $z = a \times b$. The correct order of % error in x, y and z
(1) $x = y < z$ (2) $x = y > z$
(3) $x < z < y$ (4) $x > z < y$

16. In an experiment the height of a small object is measured by a Vernier Calliper having least count 0.01 cm is found to be 7.38 cm, then the actual height of object may be :-
 (1) 7.40 cm (2) 7.3942 cm
 (3) 7.3792 cm (4) 7.3882 cm
17. Two resistance are measured in ohm and is given as:-
 $R_1 = 3\Omega \pm 1\%$
 $R_2 = 6\Omega \pm 2\%$
 When they are connected in parallel, the percentage error in equivalent resistance is
 (1) 3% (2) 4.5% (3) 0.67% (4) 1.33%
18. The percentage error in measurement of a physical quantity [m given by $m = \pi \tan \theta$] is minimum when
 (1) $\theta = 45^\circ$ (2) $\theta = 90^\circ$
 (3) $\theta = 60^\circ$ (4) $\theta = 30^\circ$
 (Assume that error in θ remain constant)
19. The number of significant digits in 0.001001 is :-
 (1) 6 (2) 4 (3) 7 (4) 2
20. The sides of a rectangle are (10.5 ± 0.2) cm and (5.2 ± 0.1) cm. Then its perimeter with error limits is :-
 (1) (31.4 ± 0.6) cm
 (2) (31.4 ± 0.3) cm
 (3) (51.6 ± 0.6) cm
 (4) (51.6 ± 0.3) cm
21. The Young modulus (Y) of a material is given by $Y = \frac{WL}{\pi r^2 \ell}$. If the percentage error in W, L, r and ℓ are 0.5%, 1%, 3% and 4% respectively then maximum percentage error in Y is -
 (1) 7.5 % (2) 9 % (3) 11.5 % (4) 13 %
22. Which of the following measurement is most precise?
 (1) 2.00 mm (2) 2.00 cm
 (3) 2.00 m (4) 2.00 km

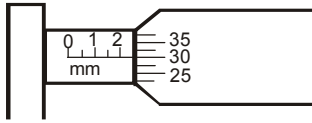
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13
Ans	3	3	4	4	3	2	1	4	4	2	4	4	4
Que.	14	15	16	17	18	19	20	21	22				
Ans	3	3	3	4	1	2	1	3	1				

Units, Dimensions & Measurements

RACE # 02

1. What is the reading of micrometer screw gauge shown in figure



- (1) 2.30 mm (2) 2.29 mm
(3) 2.36 mm (4) 2.41 mm
2. In a vernier calliper, N divisions of vernier scale coincide with $(N - 1)$ divisions of main scale (in which 1 division represents 1mm). The least count of the instrument in cm. should be

- (1) N (2) $\frac{1}{N}$ (3) $\frac{1}{10N}$ (4) $\frac{1}{N - 1}$

3. A vernier callipers having 1 main scale division 0.1 cm is designed to have a least count of 0.02 cm. If n be the number of divisions on vernier scale and m be the length of vernier scale, then
(1) $n = 10$, $m = 0.5$ cm (2) $n = 9$, $m = 0.4$ cm
(3) $n = 10$, $m = 0.8$ cm (4) $n = 10$, $m = 0.2$ cm

4. A screw gauge gives the following reading when used to measure the diameter of a wire.

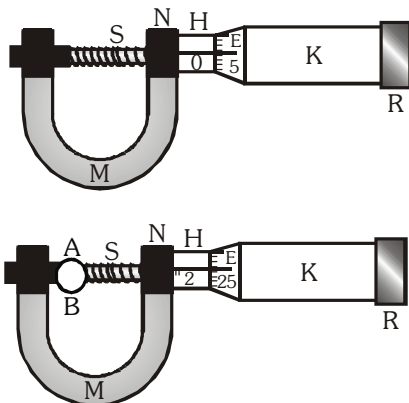
Main scale reading: 0 mm.

Circular scale reading : 52 divisions

Given that 1 mm on main scale corresponds to 100 divisions of the circular scale.

The diameter of wire from the above data is :-

- (1) 0.026 cm (2) 0.005 cm
(3) 0.52 cm (4) 0.052 cm
5. The circular scale of a screw gauge has 50 divisions and pitch of 0.5 mm. Main scale reading is 2. Find the diameter of sphere.



- (1) 1.2 mm (2) 1.25 mm
(3) 2.20 mm (4) 2.25 mm

6. The diameter of a cylinder is measured using a Vernier callipers with no zero error. It is found that the zero of the Vernier scale lies between 5.10 cm and 5.15 cm of the main scale. The Vernier scale has 50 divisions equivalent to 2.45 cm. The 24th division of the Vernier scale exactly coincides with one of the main scale divisions. The diameter of the cylinder is :-

- (1) 5.112 cm (2) 5.124 cm
(3) 5.136 cm (4) 5.148 cm

7. Two full turns of the circular scale of gauge cover a distance of 1 mm on scale. The total number of divisions on circular scale is 50. Further, it is found that screw gauge has a zero error of -0.03 mm. While measuring the diameter of a thin wire a student notes the main scale reading of 3 mm and the number of circular scale division in line, with the main scale as 35. The diameter of the wire is

- (1) 3.32 mm (2) 3.73 mm
(3) 3.67 mm (4) 3.38 mm

8. The circular scale of a micrometer has 200 divisions and pitch of 2mm. Find the measured value of thickness of a thin sheet.



- (1) 3.41 mm (2) 6.41 mm
(3) 3.46 mm (4) 6.51 mm

9. The vernier of a circular scale is divided into 30 divisions which coincide against 29 divisions of main scale. Each main scale division is 0.5° . The least count of the instrument is -

- (1) $10'$ (2) $0.1'$ (3) $1'$ (4) $30'$

10. A good analogy for understanding accuracy and precision is to imagine a basketball player shooting baskets. If the Player A shoots the ball close to or into the basket. and the Player B shoots the ball to the same location which may or may not be close to the basket.

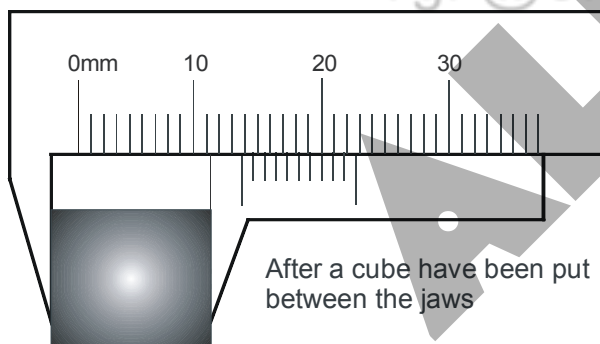
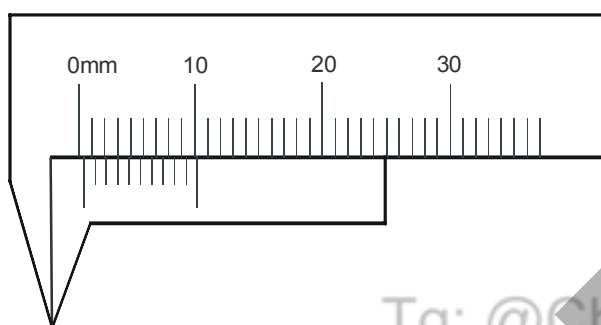
- (A) Player A is more accurate and less precise
(B) Player B is more accurate and less precise
(C) Player A is less accurate and more precise
(D) Player B is less accurate and more precise
Select correct alternative

- (1) A,B (2) B,C
(3) A,D (4) C,D

- 11.** Suppose, you are to take the measurements of the mass of a 50.0-gram standard sample with a weighing balance. You get values of 47.5, 47.6, 47.5, and 47.7 grams with weighing machine-1 and 49.8, 50.5, 51.0, 49.6 with machine-2, then
- (A) Machine 1 is more accurate and less precise
(B) Machine 2 is more accurate and less precise
(C) Machine 1 is less accurate and more precise
(D) Machine 2 is less accurate and more precise
- Select correct alternative

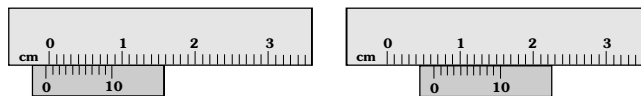
(1) A,B (2) B,C (3) A,D (4) C,D

- 12.** Find the thickness of the cubical object using a defective vernier calliper. Main scale has mm marks and 10 divisions of vernier scale coincide with 9 divisions of main scale.

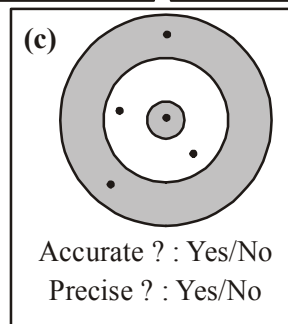
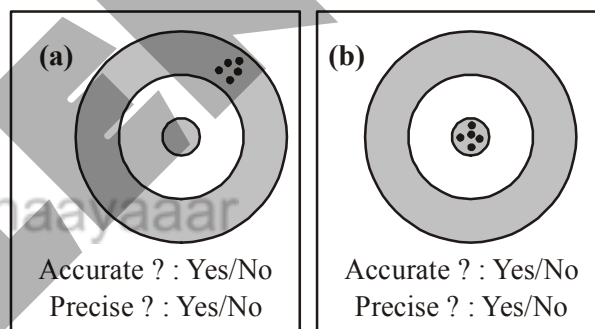


- (1) 13.8 mm (2) 13.4 mm
(3) 14.1 mm (4) 13.0 mm

- 13.** The main scale of a vernier callipers reads in millimeter and its vernier is divided into 10 divisions which coincides with 9 divisions of the main scale. The reading for shown situation is found to be $(x/10)$ mm. Find the value of x .



- 14.** The pitch of a screw gauge is 1 mm and there are 100 divisions on the circular scale. While measuring the diameter of a wire, the linear scale reads 1 mm and 47th division on the circular scale coincides with the reference line. The length of the wire is 5.6 cm. Find the curved surface area (in cm^2) of the wire in appropriate number of significant figures.
- 15.** Look at each target and decide whether the "hits" are accurate, precise, both accurate and precise or neither accurate nor precise : (Note : An accurate "hit" is a bulls eye!)



ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	
Ans	1	3	3	4	1	2	4	2	3	3	2	2	

- 13.** 69
14. 2.6 cm^2
15. (a) Precise = Yes
Accurate = No
(b) Accurate = Yes
Precise = Yes
(c) Accurate = No
Precise = No

KINEMATICS

RACE # 01

- A man covered following displacements. Find the net displacement of the person
 - 25 m west
 - 20 m 30° east of south
 - $5\sqrt{3}$ m south
 - 10 m east
 - 10 m 60° north of west
- A person moves towards north with uniform speed of 15 m/s and cover 16 m. After this he moves towards east and covers 6 m and finally covers 8 m distance with same speed in south. Find out
 - Distance travelled by person
 - Displacement of person
 - Average velocity of person
- A particle moves in a circle of radius 1 m with speed of 1 m/s. After completing half cycle. Find out :-
 - Displacement
 - Distance travelled
 - Average velocity
 - Average acceleration
- A man travels 200 km distance with the speed of 40 m/s and next 50 km with the speed of 10 m/s. Find the average speed of man.
- A man moves up on a 3 km long incline road with speed of 2 m/s, then on a 3 km level road with speed of 3 m/s and moves down on a 3 km long incline road with 6 m/s. Find the average speed of man.
- A man drives his car uniformly at 30 km/h for three hour. After it he covered next 90 km distance with uniform speed of 45 km/hr. Find the average speed of car.
- Distance between Kota and Jaipur is 240 km. Two persons A and B both start simultaneously from Kota to Jaipur. A travels half distance with 40 km/hr and remaining half distance with 60 km/hr. B travels with 40 km/hr for half time of journey and half time with 60 km/hr. Find out
 - Average speed of A and B
 - When and Who will reach the Jaipur first
- A particle is moving with constant speed v on a circular path of 'r' radius when it has moved by angle 60° , Find
 - Displacement of particle
 - Average velocity
 - Average acceleration
- A man travels one-third part of his total distance with speed v_1 and rest two-third part with speed v_2 . Find out the average speed of the man?
- A man travels half time of its journey with speed of 5 m/s and for remaining half time he moves half of its total distance travelled, with speed of 3 m/s and remaining half distance with speed of 6 m/s. Find out the average speed of the man ?

ANSWER KEY

- | | |
|--|---|
| 1. 20 m, 60° south of west | 2. (i) 30 m, 53° , N of E (ii) 10 m, (iii) 5 m/s 53° , N of E |
| 3. (i) 2m, (ii) πm , (iii) $\frac{2}{\pi}$ m/s, (iv) $\frac{2}{\pi}$ m/s ² | 4. 25 m/s 5. 3 m/s 6. 36 km/h |
| 7. (i) 48 km/h, 50 km/h, (ii) Person B, 12 min before | 8. (i) r, (ii) $\frac{3v}{\pi}$, (iii) $\frac{3v^2}{\pi r}$ |
| 10. 4.5 m/s | 9. $\frac{3v_1v_2}{v_2 + 2v_1}$ |

KINEMATICS

RACE # 02

- A particle starts moving with acceleration 2 m/s^2 . Distance travelled by it in 5th half second is :-
 (1) 1.25 m (2) 2.25 m
 (3) 6.25 m (4) 30.25 m
- A car is moving with a velocity of 10 m/s. Suddenly driver sees a child at a distance of 30 m and he applies the brakes, it produced a uniform retardation in car and car stops in 5 second. Find (mass of car=1000 kg)
 (i) the stopping distance of car
 (ii) will the car hit the child
 (iii) the retardation in car
 (iv) resistive force on car
- A body moving with uniform acceleration covers a distance of 14 m in first 2 second and 88 m in next 4 second. How much distance is travelled by it in 5th second ?
- A particle starts from rest and moves with uniform acceleration. After nth second its velocity is v then how much distance is travelled by it in last 2 second ?
- A car starts from rest and moves with uniform acceleration for time t then it moves with uniform speed of 60 km/h for time 8t, finally it moves with uniform retardation for time 3t and comes to rest. Find the average speed of car in its total journey.
- A particle starts from rest, accelerates at 2 m/s^2 for 10 s and then goes with constant speed for 30 s and then decelerates at 4 m/s^2 till it stops. What is the distance travelled by it.

ANSWER KEY

- | | | | | |
|-----------|------------------------|------------|-------------------------|-------------|
| 1. 2 | 2. (i) 25 m | (ii) No | (iii) 2 m/s^2 | (iv) 2000 N |
| 3. 24.5 m | 4. $\frac{2v(n-1)}{n}$ | 5. 50 km/h | 6. 750 m | |

KINEMATICS

RACE # 03

- A body is projected vertically upward with speed 40 m/s. The distance travelled by body in the last second of upward journey is [take $g = 9.8 \text{ m/s}^2$ and neglect effect of air resistance] :-
(1) 4.9 m (2) 9.8 m (3) 12.4 m (4) 19.6 m
- A body is thrown vertically upwards and takes 5 seconds to reach maximum height. The distance travelled by the body will be same in :-
(1) 1st and 10th second (2) 2nd and 8th second
(3) 4th and 6th second (4) Both (2) & (3)
- A ball is dropped from a height h above ground. Neglect the air resistance, its velocity (v) varies with its height (y) above the ground as :-
(1) $\sqrt{2g(h-y)}$ (2) $\sqrt{2gh}$
(3) $\sqrt{2gy}$ (4) $\sqrt{2g(h+y)}$
- A ball is thrown upward from edge of a cliff with an initial velocity of 6 m/s. How fast is it moving 1/2 s later ? ($g = 10 \text{ m/s}^2$)
- A body projected vertically upwards, reaches a height of 180 m. Find out [$g = 10 \text{ ms}^{-2}$]
(i) initial velocity of body
(ii) time taken by body to reach its maximum height
(iii) the time for which the body remains in air
(iv) height of the body from the ground after 8 sec.
(v) velocity of body at $t = 8 \text{ sec}$
(vi) the time at which the body reach the height of 100 m
(vii) A man at height of 135 m from ground tries to catch the body but he misses. After how much time from now he will be able to catch the body again ?
- A particle is projected vertically upwards from the earth. It crosses the same point at $t = 2 \text{ sec}$ and $t = 8 \text{ sec}$. Find out [$g = 10 \text{ ms}^{-2}$]
(i) the time for which particle remains in air
(ii) initial velocity of particle
(iii) maximum height attained by the particle
(iv) height of the particle at $t = 2 \text{ sec}$ and $t = 8 \text{ sec}$ from earth
- A body is dropped from the top of a tower and it covers a 80 m distance in last two seconds of its journey. Find out [$g = 10 \text{ ms}^{-2}$]
(i) height of the tower
(ii) time taken by body to reach the ground
(iii) the velocity of body when it hits the ground
- Water drops are falling from a tap at regular time intervals. When the fifth drop is near to fall from tap the first drop is at ground. If the tap is fixed at height H from ground then find out
(i) the height of the second drop from ground
(ii) distance between the second and third drop
(iii) velocity of third drop

ANSWER KEY

- | | | | |
|-------------------------|-----------------------|-----------------------------|------------|
| 1. 1 | 2. 1 | 3. 1 | 4. 1m/s |
| 5. (i) 60 m/s | (ii) 6 sec | (iii) 12 sec | (iv) 160 m |
| 6. (i) 10 sec | (ii) 50 m/s | (iii) 125 m | (iv) 80 m |
| 7. (i) 125 m | (ii) 5 sec | (iii) 50 m/s | |
| 8. (i) $\frac{7}{16} H$ | (ii) $\frac{5}{16} H$ | (iii) $\sqrt{\frac{gH}{2}}$ | |

KINEMATICS

RACE # 04

- A ball is projected in a manner such that its horizontal range is n times of the maximum height. Then find out the ratio of potential energy to kinetic energy at maximum height.
- A ball is projected from ground in such a way that after 10 seconds of projection it lands on ground 500 m away from the point of projection. Find out :-
 - angle of projection
 - velocity of projection
 - Velocity of ball after 5 seconds
- A body is projected at an angle of 45° with horizontal with velocity of $40\sqrt{2}$ m/s. Find out
 - Maximum height attained by body
 - Time of flight
 - Horizontal range
 - Velocity at maximum height
 - The ratio of Kinetic energy to potential energy at highest point
 - The path equation of projectile, assuming point of projection as origin and consider x and y are horizontal and vertical distance in meter
 - The horizontal distance covered by body in 2 seconds
 - The vertical distance covered by body in 2 second
- A body is projected from ground with velocity u making an angle θ with horizontal. Horizontal range of body is four time to maximum height attained by body. Find out
 - angle of projection
 - Range and maximum height in terms of u
 - ratio of kinetic energy to potential energy of body at maximum height
- A ball is thrown from a corner of room of length 20 m and height 5 m such that the ball moves along the length of room just touching the ceiling and drops on the other corner. Find out
 - Angle of projection
 - Velocity of projection
 - Time of flight
- A hunter aims his gun and fires a bullet directly toward's a monkey sitting on a distance tree. At the instant the bullet leaves the barrel of the gun, the monkey drops from the tree :
 - Will the bullet hit the aim ?
 - What Path of bullet will be appeared to monkey ?
 - If monkey does not drop from the tree will bullet hit the aim ?
- Stone A is dropped but stone B and C are projected horizontally ($u_C > u_B$) from top of tower of height h . then find out
 - Which stone will reach the ground earlier
 - Relation between vertical velocity of stones when they hit the ground.
- Two particles move in a uniform gravitational field with an acceleration g . At the initial moment the particles were located at one point and moved with velocity $v_1 = 1 \text{ ms}^{-1}$ and $v_2 = 4 \text{ ms}^{-1}$ horizontally in opposite directions. Find the time interval after their velocity vectors become mutually perpendicular
- A projectile is given initial velocity of $\hat{i} + 2\hat{j}$. The equation of the path is : ($g = 10 \text{ m/s}^2$)
 - $y = 2x - 5x^2$
 - $y = x - 5x^2$
 - $4y = 2x - 5x^2$
 - $y = 2x - 25x^2$

10. A particle of mass 50 g is projected horizontally from the top of a tower of height 50 m with a velocity 20 m/s. If $g = 10 \text{ m/s}^2$, then find the :-
(take downward as positive y direction)
- (1) Velocity at the instant $t = 2 \text{ s}$
 - (2) Position at the instant $t = 3 \text{ s}$
 - (3) Velocity just before hitting the ground
 - (4) Change in velocity in 2 s

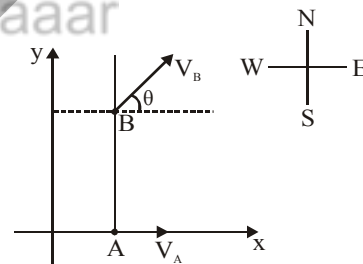
ANSWERS

1. $\frac{16}{n^2}$
2. (i) $\theta = 45^\circ$ (ii) $50\sqrt{2} \text{ m/s}$ (iii) 50 m/sec
3. (i) 80 m (ii) 8 sec (iii) 320 m (iv) 40 m/s (v) 1 : 1 (vi) $y = x - \frac{x^2}{320} \text{ m}$ (vii) 80 m (viii) 60 m
4. (i) $\theta = 45^\circ$ (ii) $R = \frac{u^2}{g}$, $H = \frac{u^2}{4g}$ (iii) 1 : 1
5. (i) 45° (ii) $10\sqrt{2} \text{ m/s}$ (iii) 2 sec
6. (i) Bullet falls by $\frac{1}{2}gt^2$ which is exactly the amount of distance the monkey falls in this same time. So the bullet will hit the aim.
(ii) Acceleration of bullet w.r.t. monkey is zero then path of bullet will be appered to monkey is straight line
(iii) If monkey does not drop from the tree then only bullet falls by $\frac{1}{2}gt^2$ so the bullet will miss the aim by distance $\frac{1}{2}gt^2$
7. (i) All stones will reach the ground at the same instant $t = \sqrt{\frac{2h}{g}}$ (ii) same for all $v_y = \sqrt{2gh}$
8. 0.2 sec 9. 1
10. (1) $20\sqrt{2} \text{ m/s}$ (2) 75 m from the point of projection (3) 37.4 m/s (4) 20 m/s

KINEMATICS

RACE # 05

- L_1 metre long train is moving with a velocity of v_1 m/s and another L_2 metre long train is moving with a velocity of v_2 m/s in opposite direction. Find out (i) The time taken by two train to cross each other (ii) Distance travel by the each train during the crossing.
- A 150 m long train is moving in north direction with a velocity of 5m/s and a parrot is also moving in north direction with a velocity of 10 m/s w.r.t. ground then find out (i) The time taken by parrot to cross the train (ii) Distance travel by the parrot during the crossing.
- A 100 m long train is moving with a velocity of 10 m/s. Find out the time taken by train to cross a bridge of length 150 m.
- A car is moving with a speed of 25 km/hour in the East. A bus is moving with a speed of $25\sqrt{3}$ km/hour in the North. What will be the relative velocity of the bus for the car's driver ?
- A car is moving with a speed of 25 km/h in East and car driver observes that a bus is moving with a speed of $25\sqrt{3}$ km/h in the north what will be actual velocity of bus.
- The wind is blowing in south with velocity of 4 km/h and observer is travelling with velocity of $4\sqrt{3}$ km/h in east. Find out the velocity of wind appeared to observer.
- An observer is travelling in west with velocity of 5 km/h and observes that wind is blowing in north with the velocity of $5\sqrt{3}$ km/h. Find out the actual velocity of wind.
- An observer is travelling in east with a velocity of 2 m/s and observes that wind is blowing in north with a velocity of 2m/s. If observer doubles his velocity then find out the velocity of wind appears to observer ?
- Rain is falling vertically downwards with a velocity of 2 m/s. A person is running to the North with a velocity of $2\sqrt{3}$ m/s. Find out the velocity and direction of rain as appeared to the person.
- A person is walking to the east at 2 km/hr and the rain drops appear to him dropping vertically downwards at $2\sqrt{3}$ km/hr. Find the actual velocity of rain.
- Figure shows two ships moving in x-y plane with velocities V_A and V_B . The ships move such that B always remains north of A. The ratio $\frac{V_A}{V_B}$ is equal to :-



- (1) $\cos \theta$
- (2) $\sin \theta$
- (3) $\sec \theta$
- (4) $\operatorname{cosec} \theta$

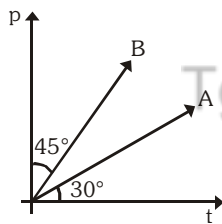
ANSWER KEY

- (i) $t = \frac{L_1 + L_2}{v_1 + v_2}$ (ii) $d_1 = v_1 \times \left(\frac{L_1 + L_2}{v_1 + v_2} \right)$, $d_2 = v_2 \times \left(\frac{L_1 + L_2}{v_1 + v_2} \right)$
- (i) 30 sec (ii) 300 m
- 25 sec
- 50 km/hour, 30° towards the west of north.
- 50 km/h (60° N of E)
- 8 km/h, 30° S of W
- 10 km/h, 30° W of N
- $2\sqrt{2}$ m/s N-W
- 4 m/s In south direction, at 60° with vertical
- 10.4 km/hr at an angle of 30° with the vertical
- 1

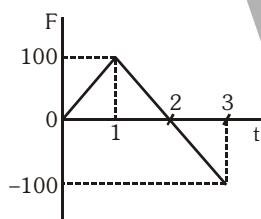
NEWTON'S LAWS OF MOTION

RACE # 01

- There are two bodies A & B of same mass, body A is at rest while body B is under going uniform motion, which is correct statements?
(1) Inertia of A > inertia of B.
(2) Inertia of B > inertia of A.
(3) Inertia of A = inertia of B.
(4) Either 1st, 2nd or 3rd is correct, depending upon the shape of body.
- A particle is acted upon by a force given by $F = (12t + 3t^2)\text{N}$, where t is in seconds. Find the change in momentum of that particle from $t = 1$ to $t = 3$ sec.
- For the given momentum-time (p - t) graphs find the ratio of force on particles A & B.



- For the given F - t graph. Find Impulse in first 3 sec.



- A ball of mass 2 kg is moving with velocity 20 m/sec strikes normally with the surface and rebounds with same speed, if time of contact is 0.1 sec then calculate average force on the ball.
- A machine gun fire bullets of mass 40 gm each with the velocity of 1000 m/sec. If average force is exerted on the gun F is 400 N, then find the no. of bullets fired per minute.

- When a same force is applied on two different objects. It produces accelerations of 4 m/sec^2 and 6 m/sec^2 . In these objects, if the same force is applied on the combination of these objects, calculate acceleration of combination.
- A body moving with uniform velocity is stopped in 0.25 second by applying a retarding force of 200 Newton. The initial momentum of the body will be :-
(1) 50 N-s (2) 100 N-s
(3) 150 N-s (4) Zero
- The exhaust velocity of gases with respect to a small rocket of mass 25 kg. is $28 \times 10^2 \text{ m/s}$. At what rate the fuel must burn so that it may rise up with an acceleration of 9.8 m/s^2 in earth gravitation field ?
(1) 175 Kg (2) 1.75 Kg/s
(3) 0.175 Kg/s (4) Zero
- At a place where the acceleration due to gravity is 10 m/s^2 , a force of 5 kg-wt acts on a body in horizontal direction on mass of 10 kg which is initially at rest. The velocity of the body after 4 s is :-
(1) 5 m/s (2) 20 m/s
(3) 10 m/s (4) 50 m/s
- Suppose a rocket with an initial mass M_0 eject a mass Δm in the form of gases in time Δt , then the mass of the rocket after time t is :-
(1) $M_0 - \frac{\Delta m}{\Delta t} \cdot t$ (2) $M_0 - \frac{\Delta m}{\Delta t}$
(3) $M_0 + \frac{\Delta m}{\Delta t}$ (4) M_0
- A cart is moving with a velocity 20 m/s. Sand is being dropped into the cart at the rate of 50 kg/min. The force required to move the cart with constant velocity will be :-
(1) 50 N (2) 30.33N
(3) 26.45N (4) 16.66N

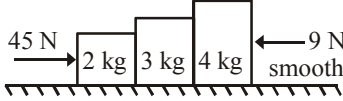
13. A body of mass m is projected with initial speed u at an angle θ with the horizontal. The change in momentum of body after time t is :-
- (1) $m u \sin \theta$ (2) $2 m u \sin \theta$
 (3) $m g t$ (4) zero
14. If impulse I (in Kg m/s) varies with time t as $I = 20t^2 - 40t$. The change in momentum is minimum at :-
- (1) $t = 2 \text{ s}$ (2) $t = 1 \text{ s}$ (3) $t = \frac{1}{2} \text{ s}$ (4) $t = \frac{3}{2} \text{ s}$
15. The average force necessary to stop a hammer with momentum p (in N-s) in 0.5 s is :-
- (1) $2p \text{ N}$ (2) $p \text{ N}$ (3) $4p \text{ N}$ (4) $\frac{p}{2} \text{ N}$

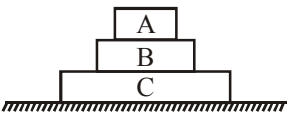
ANSWERS

1. (3) 2. 74 kg m/sec 3. $\frac{F_A}{F_B} = \frac{\tan 30^\circ}{\tan 45^\circ} = \frac{1}{\sqrt{3}}$ 4. 50 N-s 5. 800 N
6. 600 bullets 7. $a = 2.4 \text{ m/s}^2$ 8. 1 9. 3 10. 2 11. 1 12. 4 13. 3
14. 2 15. 1

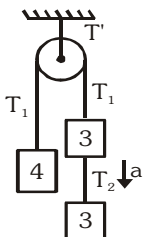
NEWTON'S LAWS OF MOTION

RACE # 02

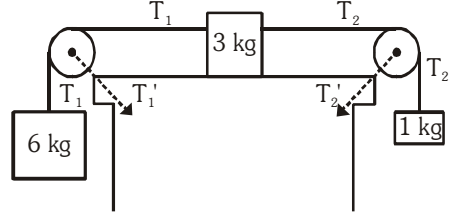
- A man of mass 60 kg is in a lift and lift is accelerating upwards with acceleration 4 m/s^2 . Calculate effective weight of man in lift. ($g = 10 \text{ m/s}^2$)
- Effective weight of man of mass 50 kg in a lift is 600 N. Lift is accelerating upwards. Calculate acceleration of lift. ($g = 10 \text{ m/s}^2$)
- 

Find interaction force between 3 kg and 4 kg block.
- A beaker containing some water is lying on the pan of a spring balance. If one dips finger in the water without touching its bottom, then the reading of the balance will :-
 (1) increase
 (2) decrease
 (3) remain constant
 (4) depend upon the material of beaker
- A boy standing on a weighing machine notices his weight as 400 N. When he suddenly jumps upward, the weight shown by the machine becomes 600 N. The acceleration with which the boy jumps up is :- ($g = 10 \text{ m/s}^2$)
 (1) 5 ms^{-2} (2) 3.4 ms^{-2} (3) 6 ms^{-2} (4) 9.8 ms^{-2}
- Three blocks are placed as shown in figure. Mass of A, B and C are m_1 , m_2 , and m_3 respectively. The force exerted by block 'C' on 'B' is :-


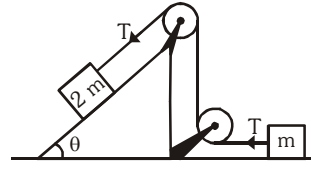
- (1) $m_1 g$ (2) $(m_1 + m_2)g$
 (3) $m_2 g$ (4) $(m_1 + m_2 + m_3)g$

- 

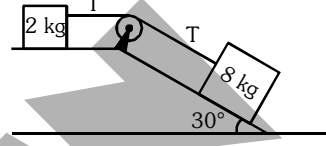
Find a , T_1 , T_2 , T .
 (All masses are in Kg)
 ($g = 10 \text{ m/s}^2$)

- 

Calculate a , T_1 , T_2 , T_1' & T_2' . ($g = 10 \text{ m/s}^2$)

- 

Calculate a & T .
 ($g = 10 \text{ m/s}^2$)

- 

Calculate a & T .
 ($g = 10 \text{ m/s}^2$)

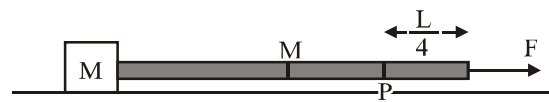
- 

Calculate a & T .
 (All masses are in Kg and take $g = 10 \text{ m/s}^2$)

- 80 railway wagons all of same mass $5 \times 10^3 \text{ kg}$ are pulled by an engine with a force of $4 \times 10^5 \text{ N}$. The tension in the coupling between 30th and 31st wagon from the engine is :-

- (1) $400 \times 10^4 \text{ N}$
 (2) $32 \times 10^4 \text{ N}$
 (3) $20 \times 10^4 \text{ N}$
 (4) $25 \times 10^4 \text{ N}$

- A block of mass M is pulled by a uniform chain of mass M tied to it by applying a force F at the other end of the chain. The tension force at a point located at a distance of one-fourth of the chain's length from the free end of chain will be:-

- 
- (1) $\frac{7F}{8}$ (2) $\frac{4F}{5}$
 (3) $\frac{3F}{4}$ (4) $\frac{6F}{7}$

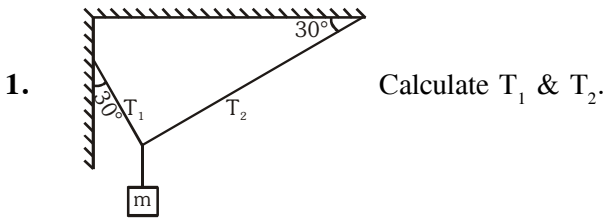
14. A sphere is accelerated upwards with the help of a cord whose breaking strength is five times its weight. The maximum acceleration with which the sphere can move up without cord breaking is :-
- (1) $4g$ (2) $3g$
 (3) $2g$ (4) g
15. In a tug of war contest, two men pull on a horizontal rope at the two ends, The winner :-
- (1) exerts a force on the rope which is greater than the tension
 (2) exerts greater force on the ground
 (3) exerts greater force on the rope
 (4) none of the above

ANSWERS

1. 840 N 2. 2 m/s^2 3. 25 N 4. 1 5. 1 6. 2
7. $a = 2 \text{ m/sec}^2$, $T_1 = 48 \text{ N}$, $T_2 = 24 \text{ N}$, $T' = 96 \text{ N}$
8. $a = 5 \text{ m/sec}^2$, $T_1 = 30 \text{ N}$, $T_2 = 15 \text{ N}$, $T_1' = 30\sqrt{2} \text{ N}$, $T_2' = 15\sqrt{2} \text{ N}$ 9. $a = \frac{2g \sin \theta}{3}$, $T = \frac{2mg \sin \theta}{3}$
10. $a = 4 \text{ m/sec}^2$, $T = 8 \text{ N}$ 11. $a = 3 \text{ m/sec}^2$, $T = 8 \text{ N}$ 12. 4 13. 1
14. 1 15. 2

NEWTON'S LAWS OF MOTION

RACE # 03

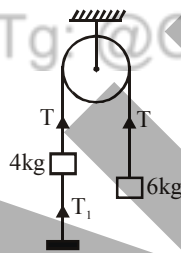


2. A bird is sitting on stretched telephone wire. If its weight is W then the additional tension produced by it in the wire will be :-

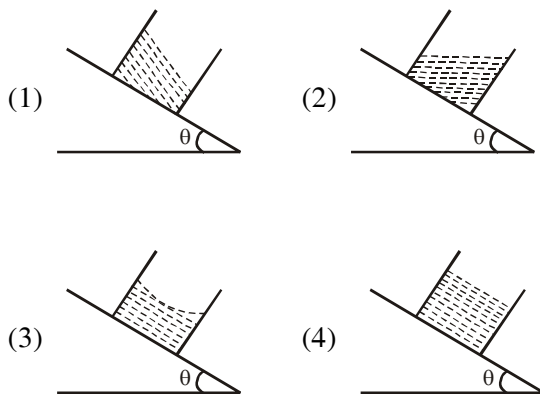
- (1) $T = W$ (2) $T > W$
(3) $T < W$ (4) $T = 0$

3. Two bodies of mass 4 kg and 6 kg are attached to the ends of a string passing over a pulley. The 4 kg mass is attached to the table top by other string. The tension in this string T_1 is equal to :-

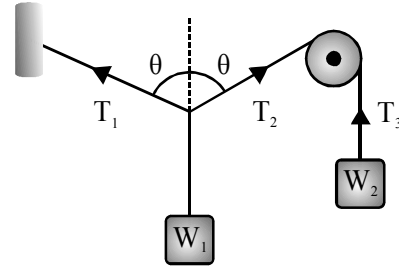
- (1) 10 N
(2) 10.6 N
(3) 25 N
(4) 20 N



4. A beaker is half filled with water. It is allowed to slip down on smooth inclined plane with angle of inclination θ to the horizontal. The level of water in the beaker will be :-



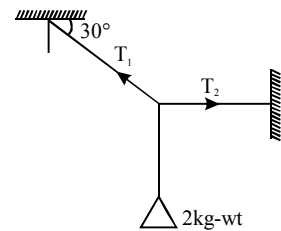
5. In the following figure, the pulley is massless and frictionless. The relation between T_1 , T_2 and T_3 will be :-



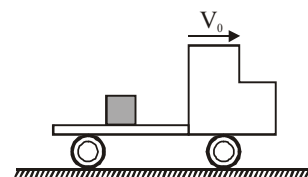
- (1) $T_1 = T_2 \neq T_3$ (2) $T_1 \neq T_2 = T_3$
(3) $T_1 \neq T_2 \neq T_3$ (4) $T_1 = T_2 = T_3$

6. A body of weight 2 kg is suspended as shown in the figure. The tension T_2 in the horizontal string (in kg wt) is :-

- (1) $2/\sqrt{3}$
(2) $\sqrt{3}/2$
(3) $2\sqrt{3}$
(4) $3\sqrt{2}$



7. An iron block of mass $m = 500$ kg is kept at the back of a truck moving at a speed $v_0 = 90$ km h^{-1} . The driver applies the brakes and slows down to a speed of $v = 54$ km h^{-1} in 10 s. What constant force acts on the block during this time if the block not slide on the truck-bed :-



- (1) -500 N (2) -300 N
(3) -400 N (4) None of these

8. The concept of inertia is explained in :-

- (1) Newton's first law
- (2) Newton's second law
- (3) Newton's third law
- (4) All of these

9. Select correct statement regarding pseudo force :-

- (1) It is electromagnetic in origin
- (2) Newton's 3rd law is applicable for it
- (3) It is a fundamental force
- (4) It is used to make Newton's law applicable in non-inertial frame

ALLEN

Tg: @Chalnaayaaar

ANSWERS

- | | | | | | | | | |
|---|------|------|------|------|------|------|------|------|
| 1. $T_1 = \frac{\sqrt{3}}{2}mg, T_2 = \frac{mg}{2}$ | 2. 2 | 3. 4 | 4. 4 | 5. 4 | 6. 3 | 7. 1 | 8. 1 | 9. 4 |
|---|------|------|------|------|------|------|------|------|

FRICTION

1. A block of mass 1 kg is placed on a surface for which $\mu_s = 0.2$ & $\mu_k = 0.15$, an external force F is applied on the block as shown in the figure, using $g = 10 \text{ m/sec}^2$, find :-

(a) The force of friction on block

(b) Its acceleration

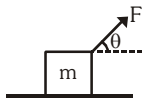
(i) When $F = 1 \text{ N}$

(ii) When $F = 2 \text{ N}$

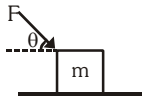
(iii) When $F = 2.5 \text{ N}$



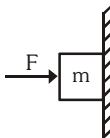
2. Find value of pulling force F for which block just moves. Given coefficient of friction for surface is μ .



3. Find value of pushing force F for which the body just moves. (Coefficient of friction for surface is μ)



4. Find the minimum value of horizontal force (F) required on the block of mass m to keep it at rest on the wall. Given the coefficient of friction between the surfaces is μ .



5. $\mu = 0.4$

For the given arrangement, find :-

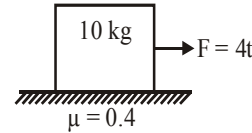
(i) Force of friction on the block.

(ii) Acceleration of the block.

(iii) Minimum Force required to prevent the downward sliding of block.

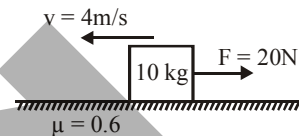
(iv) Minimum Force required to just move the block upwards.

6. A block of mass 10 kg is kept over a rough surface and a force $F = 4t$ is applied on it. At what value of t the block will start moving :- ($g = 10 \text{ m/s}^2$)



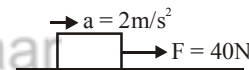
- (1) $> 10 \text{ s}$ (2) $< 8 \text{ s}$
(3) $= 9 \text{ s}$ (4) None of these

7. A block of mass 10 kg is moving on a rough surface as shown in figure. The frictional force acting on block is :- ($g = 10 \text{ m/s}^2$)



- (1) 20 N (2) 60 N (3) 40 N (4) 80 N

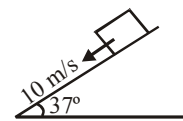
8. A block of mass 10 kg, moving with acceleration 2 m/s^2 on horizontal rough surface is shown in figure



The value of coefficient of kinetic friction is :- ($g = 10 \text{ m/s}^2$)

- (1) 0.2 (2) 0.4 (3) 0.5 (4) 0.1

9. Block of mass 10 kg is moving on inclined plane with constant velocity 10 m/s. The coefficient of kinetic friction between inclined plane and block is :-

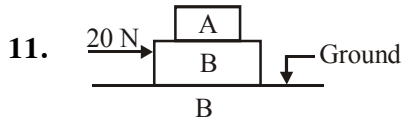


- (1) 0.57 (2) 0.75
(3) 0.5 (4) None of these

10. 10 kg 20 kg
Smooth rough

The ratio of acceleration of blocks A placed on smooth incline with block B placed on rough incline is 2 : 1. The coefficient of kinetic friction between block B and incline is :-

- (1) 0.5 (2) 0.75
(3) 0.57 (4) None of these



Blocks shown in figure moves with constant velocity 10 m/s towards right. All surfaces in contact are rough. The friction force applied by B on A is :-

- (1) 0 N
- (2) 20 N
- (3) 10 N
- (4) insufficient data

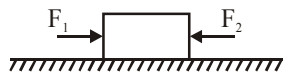
ANSWERS

- | | | |
|---|---|---|
| 1. (i) $f = 1\text{ N}$, $a = 0$ | (ii) $f = 2\text{ N}$, $a = 0\text{ m/s}^2$ | (iii) $f = 1.5\text{ N}$, $a = 1\text{ m/s}^2$ |
| 2. $F = \frac{\mu mg}{\cos\theta + \mu \sin\theta}$ | 3. $F = \frac{\mu mg}{\cos\theta - \mu \sin\theta}$ | 4. $F = \frac{mg}{\mu}$ |
| 5. (i) 12.8 N | (ii) 2.8 m/s ² | (iii) 11.2 N |
| 6. 1 | 7. 2 | (iv) 36.8 N |
| 8. 1 | 9. 2 | 10. 1 |
| | | 11. 1 |

WORK, POWER & ENERGY

RACE # 01

1. A block of mass 2 kg is placed on a smooth horizontal surface. Two forces $F_1 = 20$ N and $F_2 = 5$ N start acting on the block in opposite directions as shown. If block gets displaced by 5 m in the direction of net force then work done by F_2 is :-



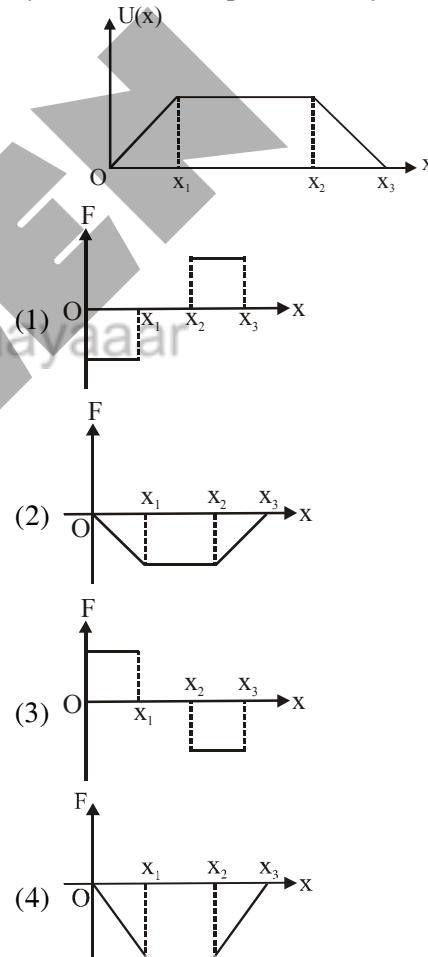
- (1) - 75 J (2) 75 J (3) - 25 J (4) 25 J
2. A man of mass 50 kg is standing in an elevator. If elevator is moving up with an acceleration $\frac{g}{3}$ then work done by normal reaction of elevator floor on man when elevator moves by a distance 12 m is ($g = 10 \text{ m/s}^2$) :-
- (1) 2000 J (2) 4000 J (3) 6000 J (4) 8000 J
3. A cubical vessel of height 1 m is full of water. Minimum work done against gravity in taking water-out from vessel will be :- ($g = 10 \text{ m/s}^2$)
- (1) 5000 J (2) 10,000 J
(3) 5 J (4) 10 J
4. A man pulls a bucket full of water from h metre deep well. If the mass of rope is m and mass of bucket full of water is M, then work done by the man is :-

- (1) $\left(\frac{M}{2} + m\right)gh$ (2) $\left(\frac{M+m}{2}\right)gh$
(3) $\left(M + \frac{m}{2}\right)gh$ (4) $(M + m)gh$

5. The potential energy of an object of mass m moving in xy plane in a conservative field is given by $U = ax + by$, where x and y are position coordinates of the object. Find magnitude of its acceleration :-

- (1) $\frac{\sqrt{a^2 + b^2}}{m}$ (2) $\frac{a^2 + b^2}{m}$
(3) $\sqrt{a^2 + b^2}$ (4) None of these

6. The variation of potential energy U of a system is shown in figure. The force acting on the system is best represented by :-



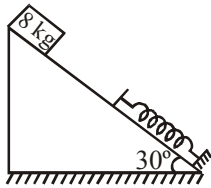
ANSWER KEY

Que.	1	2	3	4	5	6	
Ans	3	4	1	3	1	1	

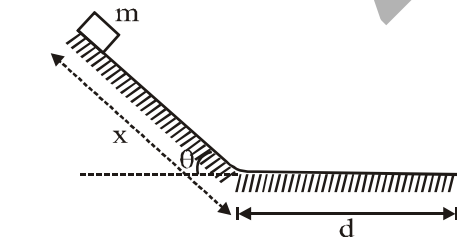
WORK POWER & ENERGY

RACE # 02

1. A block of mass 8 kg is released from the top of an inclined smooth surface as shown in figure. If spring constant of spring is 200 N/m and block comes to rest after compressing spring by 1 m then find the distance travelled by block before it comes to rest :-
($g = 10 \text{ m/s}^2$)

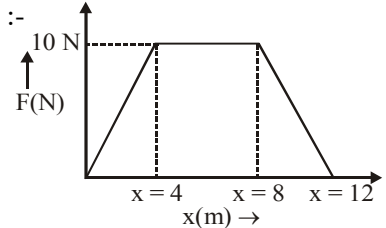


- (1) 2.5 m (2) 3.5 m
(3) 2.0 m (4) None of these
2. The position (x) of a body moving along x -axis at time (t) is given by $x = 3t^2$, where x is in metre and t is in second. If mass of body is 2 kg, then find the instantaneous power delivered to body by force acting on it at $t = 4 \text{ s}$:-
(1) 288 W (2) 280 W
(3) 290 W (4) None of these
3. A block of mass m is released from the top of a smooth inclined plane of length x and inclination θ as shown in figure. Horizontal surface is rough. If block comes to rest after moving a distance d on the horizontal surface, then coefficient of friction between block and surface is :-



- (1) $\frac{x \sin \theta}{2d}$ (2) $\frac{x \cos \theta}{2d}$
(3) $\frac{x \sin \theta}{d}$ (4) $\frac{x \cos \theta}{d}$

4. A particle of mass 0.1 kg is subjected to a force which varies with distance as shown. If it starts its journey from rest at $x = 0$, then its velocity at $x = 12 \text{ m}$ is :-



- (1) 0 m/s
(2) $20\sqrt{2} \text{ m/s}$
(3) $20\sqrt{3} \text{ m/s}$
(4) 40 m/s
5. A car of mass m has an engine which can deliver power P . The minimum time in which car can be accelerated from rest to a speed v is :-

- (1) $\frac{mv^2}{2P}$ (2) Pmv^2
(3) $2Pmv^2$ (4) $\frac{mv^2}{2}P$

6. The rate of doing work by force acting on a particle moving along x -axis depends on position x of particle and is equal to $2x$. The velocity of particle is given by expression :-

- (1) $\left[\frac{3x^2}{m}\right]^{1/3}$ (2) $\left[\frac{3x^2}{2m}\right]^{1/3}$
(3) $\left[\frac{2mx}{9}\right]^{1/2}$ (4) $\left[\frac{mx^2}{3}\right]^{1/2}$

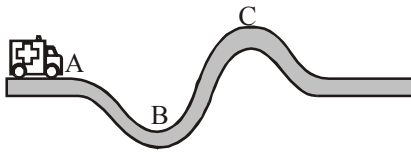
ANSWER KEY

Que.	1	2	3	4	5	6
Ans	1	1	3	4	1	1

CIRCULAR MOTION

- A particle of mass m is moving in a circle of radius r under a centripetal force equal to $\frac{-K}{r^2} \hat{r}$, where K is constant. What is the total energy of the particle ?
 (1) $-K/2r$ (2) $K/4r$
 (3) K/r (4) None of these
- If a_r and a_t represents radial and tangential acceleration, the motion of a particle will be circular if :-
 (i) $a_r = 0$ and $a_t = 0$ (ii) $a_r = 0$ but $a_t \neq 0$
 (iii) $a_r \neq 0$ but $a_t = 0$ (iv) $a_r \neq 0$ and $a_t \neq 0$
 (1) (i, iii) (2) (ii, iii)
 (3) (iii, iv) (4) (ii, iv)
- A particle P is moving in a circle of radius ' a ' with uniform speed v . C is the centre of the circle and AB is a diameter. The angular velocity of P about A and C are in the ratio :-
 (1) $1 : 1$ (2) $1 : 2$
 (3) $2 : 1$ (4) $4 : 1$
- A motor car is travelling at 60 m/s on a circular road of radius 1200 m . It is increasing its speed at the rate of 4 m/s^2 . The acceleration of the car is :-
 (1) 3 m/s^2 (2) 4 m/s^2
 (3) 5 m/s^2 (4) 7 m/s^2
- The speed of a particle moving in a circle slows down at a rate of 3 m/sec^2 . At some instant the magnitude of the total acceleration is 5 m/sec^2 and the particle's speed is 12 m/sec . The radius of circle will be :-
 (1) 12 m (2) 24 m (3) 36 m (4) 48 m
- A particle moves along a circle with speed $v = at$. The total acceleration of the particle at a time when it has traced $1/8$ th of the circumference is :-
 (1) $\frac{v}{8a}$ (2) $2a\sqrt{4 + \pi^2}$
 (3) a (4) $\frac{a}{2}\sqrt{4 + \pi^2}$
- Railway tracks are banked at the curves so that :-
 (1) the train may not fall down inwards
 (2) the weight of the train may be reduced
 (3) the necessary centripetal force to train may be obtained from the horizontal component of the reaction force of railway tracks
 (4) no frictional force may be produced between the wheel and the track
- A spaceman during training period is rotated in a seat at the end of a horizontal arm of length 5 m . If he can withstand acceleration upto $9g$, then what is the maximum number of revolutions per second permissible ?
 (Take $g = 10 \text{ m/s}^2$)
 (1) 13.5 rev/s (2) 1.35 rev/s
 (3) 0.675 rev/s (4) 6.75 rev/s
- The maximum velocity (in ms^{-1}) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is :- ($g = 10 \text{ m/s}^2$)
 (1) 60 (2) 30
 (3) 15 (4) 25
- A 2 kg stone at the end of a string 1 m long is whirled in a vertical circle. At some point its speed is 4 m/s . The tension of the string is 51.6 newton . At this instant the stone is :-
 (1) at the top of the circle
 (2) at the bottom of the circle
 (3) half way down
 (4) none of these
- A particle rests on the top of a hemisphere of radius R . Find the smallest horizontal velocity that must be imparted to the particle if it is to leave the hemisphere without sliding down :-
 (1) $\sqrt{gR}$ (2) $\sqrt{2gR}$
 (3) $\sqrt{3gR}$ (4) $\sqrt{5gR}$

12. A vehicle is moving on a track with constant speed as shown in Fig. The normal reaction between tyre's and road is :-



- (1) maximum at A
- (2) maximum at B
- (3) maximum at C
- (4) same at A, B and C

Tg: @Chalnaayaaar

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	
Ans	1	3	2	3	3	4	3	3	2	2	1	2	

COLLISION AND CENTRE OF MASS

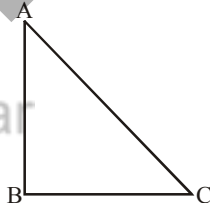
- A disc of radius r is cut from a larger disc of radius $4r$ in such a way that the edge of the hole touches the edge of the disc. The centre of mass of the residual disc will be at a distance from centre of larger disc :-
 (1) $\frac{r}{5}$ (2) $\frac{r}{4}$ (3) $\frac{r}{2}$ (4) $\frac{r}{3}$
- Two particles of mass m_1 and m_2 are projected from the top of a tower. The particle m_1 is projected vertically downward with speed u and m_2 is projected horizontally with same speed. Find acceleration of CM of system of particles by neglecting the effect of air resistance.
 (1) g downward
 (2) $\frac{m_1 g}{m_1 + m_2}$ downward
 (3) $\frac{m_2 g}{m_1 + m_2}$ downward
 (4) Can't be predicated
- A cart of mass M is tied to one end of a massless rope of length $10m$. The other end of the rope is in the hands of a man of mass $\frac{M}{2}$. The entire system is on a smooth horizontal surface. If the man pulls the cart by the rope then find the distance by which the man will slip on the horizontal surface before the man and the cart will meet each other.
 (1) $\frac{20}{3}m$ (2) $\frac{10}{3}m$
 (3) 0 (4) None of these
- Two point masses m_1 and m_2 at rest in gravity free space are released from distance d . Find the velocity of the CM of the system at the time of collision of particles.
 (1) Zero (2) 2
 (3) 3 (4) None of these
- Two blocks of masses 5kg and 2kg are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse provides a velocity of 7m/s to the heavier block in the direction of the lighter block. The velocity of the centre of mass is :-
 (1) 4 m/s (2) 5m/s (3) 2m/s (4) 3m/s
- A shell at rest on a smooth horizontal surface explodes into two fragments of masses m_1 and m_2 . If just after explosion, m_1 move with speed u , then work done by internal forces during explosion is:-
 (1) $\frac{1}{2}(m_1 + m_2)\frac{m_2}{m_1}u^2$ (2) $\frac{1}{2}(m_1 + m_2)u^2$
 (3) $\frac{1}{2}m_1u^2\left(1 + \frac{m_1}{m_2}\right)$ (4) $\frac{1}{2}(m_2 - m_1)u^2$
- A body of mass 2 kg moving with a velocity of 3 m/s collides head on with a body of mass 1 kg moving with a velocity of 4 m/s in opposite direction. After collision the two bodies stick together and move with a common velocity :-
 (1) $(1/4)\text{ m/s}$ (2) $(1/3)\text{ m/s}$
 (3) $(2/3)\text{ m/s}$ (4) $(3/4)\text{ m/s}$
- A ball is dropped on the ground from a height of 1m . the coefficient of restitution is 0.6 . The height to which the ball will rebound is :-
 (1) 0.6 m (2) 0.4 m (3) 0.36 m (4) 0.16 m
- A massive ball moving with speed v collides with a tiny ball which is initially at rest having a mass very much smaller than the mass of the first ball. The collision is elastic, then immediately after the impact, the second ball will move with a speed approximately equal to :-
 (1) v (2) $2v$ (3) $v/2$ (4) ∞

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9
Ans	1	1	1	1	2	3	3	3	2

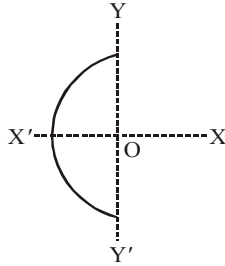
ROTATIONAL MOTION

RACE # 01

- A fan is rotating with a speed of 450 rev/minute. After being switched off it comes to rest in 10s. Assuming constant angular deceleration, calculate the number of revolutions made by it before coming to rest.
(1) 37.5 (2) 37
(3) 38.5 (4) None of these
- A disc rotating about its axis from rest, acquires the angular speed 100 rev/s in 4 second. The angle rotated by it during these seconds (in radian) is :-
(1) 100π (2) 200π (3) 300π (4) 400π
- A body rotating with uniform angular acceleration covers 100π (radian) in the first 5s after the start. Its angular speed at the end of 5s (in radian/s) is :-
(1) 40π (2) 30π
(3) 20π (4) 10π
- A wheel starting from rest is uniformly accelerated at 2 rad/s^2 for 20 seconds. It is allowed to rotate uniformly for the next 10 seconds and is finally brought to rest in next 20 seconds. The total angle rotated by the wheel (in radian) is :-
(1) 600 (2) 1200
(3) 1800 (4) 300
- A body rotates about a fixed axis with an angular acceleration of 3 rad/s^2 . The angle rotated by it during the time when its angular velocity increases from 10 rad/s to 20 rad/s (in radian) is :-
(1) 50 (2) 100
(3) 150 (4) 200
- For a disc of given density and thickness, its moment of inertia varies with radius of the disc as :-
(1) $I \propto R^2$ (2) $I \propto R^4$
(3) $I \propto R^3$ (4) $I \propto R$
- If a disc of moment of inertia I and radius r is reshaped into a ring of radius nr , keeping its mass same, its moment of inertia becomes :-
(1) n^2I (2) $2n^2I$ (3) $\frac{n^2}{2}I$ (4) I
- Two circular loops A and B of radii R and $2R$ respectively are made of the similar wire. Their moment of inertia about the axis passing through the centre and perpendicular to their plane are I_A and I_B respectively. The ratio $\frac{I_A}{I_B}$ is :-
(1) $\frac{1}{4}$ (2) $\frac{1}{8}$ (3) $\frac{1}{2}$ (4) 1
- A thin uniform metallic triangular sheet of mass M has sides $AB = BC = L$. What is its moment of inertia about axis AC lying in plane of sheet ?

(1) $\frac{ML^2}{12}$ (2) $\frac{2ML^2}{3}$ (3) $\frac{ML^2}{3}$ (4) $\frac{ML^2}{6}$
- The radius of gyration (K) of a rigid body changes with change of :-
(1) Angular speed (2) Axis of rotation
(3) Both (1) and (2) (4) Never changes
- Three rods each of mass m and length L are joined to form an equilateral triangle as shown in the figure. What is the moment of inertia about an axis passing through the centre of mass of the system and perpendicular to the plane ?

(1) $2 mL^2$ (2) $\frac{mL^2}{2}$ (3) $\frac{mL^2}{3}$ (4) $\frac{mL^2}{6}$

12. A thin wire of length ℓ and mass m is bent in the form of a semicircle as shown. Its moment of inertia about an axis joining its free ends will be :-



- (1) $m\ell^2$ (2) Zero (3) $\frac{m\ell^2}{\pi^2}$ (4) $\frac{m\ell^2}{2\pi^2}$

Tg: @Chalnaayaaar

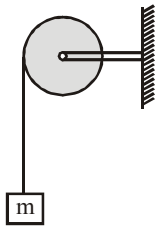
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	
Ans	1	4	1	2	1	2	2	2	1	2	2	4	

ROTATIONAL MOTION

RACE # 02

1. A disc of mass m and radius r is free to rotate about its centre as shown in the figure. A string is wrapped over its rim and a block of mass m is attached to the free end of the string. The system is released from rest. The speed of the block as it descends through a height h , is :-



- (1) $\sqrt{2gh}$ (2) $\sqrt{\frac{2}{3}gh}$
(3) $2\sqrt{\frac{gh}{3}}$ (4) $\frac{1}{2}\sqrt{3gh}$

2. A particle of mass m has been thrown up with initial speed u making an angle θ with the horizontal. Find the torque of its weight about the point of projection when it just reached the highest point.

- (1) $mu \sin\theta \cdot \cos\theta$ (2) $m u^2 \sin\theta \cos\theta$
(3) $\frac{mu \sin^2\theta}{2}$ (4) $\frac{mu^2 \sin^2\theta}{2}$

3. The torque of force $\vec{F} = -2\hat{i} + 2\hat{j} + 3\hat{k}$ acting on a point $\vec{r} = \hat{i} - 2\hat{j} + \hat{k}$ about origin will be :-

- (1) $8\hat{i} + 5\hat{j} + 2\hat{k}$
(2) $-8\hat{i} - 5\hat{j} - 2\hat{k}$
(3) $8\hat{i} - 5\hat{j} + 2\hat{k}$
(4) $-8\hat{i} + 5\hat{j} - 2\hat{k}$

4. Moment of a force of magnitude 20 N acting along positive x direction at point $(3m, 0, 0)$ about the point $(0, 2m, 0)$ (in N-m) is :-

- (1) 20 (2) 60
(3) 40 (4) 30

5. A disc is rotating with angular velocity $\vec{\omega}$. A force $\vec{F}$ acts at a point whose position vector with respect to the axis of rotation is $\vec{r}$. The power associated with torque due to the force is given by :

- (1) $(\vec{r} \times \vec{F}) \cdot \vec{\omega}$
(2) $(\vec{r} \times \vec{F}) \times \vec{\omega}$
(3) $\vec{r} \times (\vec{F} \cdot \vec{\omega})$
(4) $\vec{r} \cdot (\vec{F} \times \vec{\omega})$

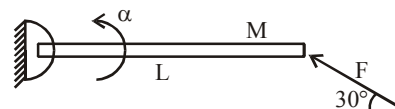
6. When torque applied on a system is zero, which of the following will be constant ?

- (1) Moment of inertia
(2) Angular velocity
(3) Kinetic energy
(4) Moment of linear momentum

7. Two boys are holding a horizontal rod of length L and weight W through its two ends. If now one of the boys suddenly leaves the rod, what is the instantaneous reaction force experienced by the other boy ?

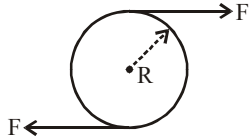
- (1) $\frac{W}{4}$ (2) $\frac{W}{2}$
(3) $\frac{3W}{4}$ (4) W

8. The thin rod shown below has mass M and length L . A force F acts at one end as shown and the rod is free to rotate about the other end in horizontal plane. Initial angular acceleration of the rod is :



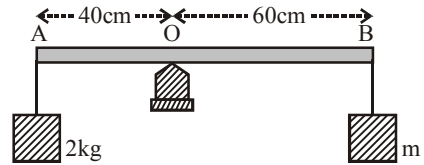
- (1) $\frac{3F}{2ML}$ (2) $\frac{2F}{3ML}$
(3) $\frac{F}{ML}$ (4) $\frac{F}{2ML}$

9. Two equal and opposite forces are applied tangentially on a uniform disc of mass M and radius R as shown in the figure. If the disc is pivoted at its centre and free to rotate in its plane, the angular acceleration of the disc is :



- (1) $\frac{F}{MR}$ (2) $\frac{2F}{3MR}$
 (3) $\frac{4F}{MR}$ (4) Zero

10. Figure shows a rigid massless rod of length 1.0 m. It is pivoted at O. For what value m , the rod will be in equilibrium ? Find the force (F) exerted on the rod by the pivot. Neglect the weight of the rod. ($g = 10 \text{ m/s}^2$)



ANSWER KEY

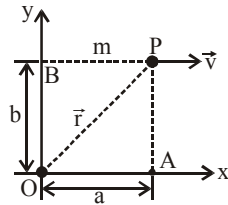
Que.	1	2	3	4	5	6	7	8	9	10
Ans	3	2	2	3	1	4	1	1	3	$m = 4/3 \text{ kg}, F = 100/3 \text{ N}$

ROTATIONAL MOTION

RACE # 03

1. A particle is moving along a straight line parallel to x-axis with constant velocity. Find angular momentum about the origin in vector form :-

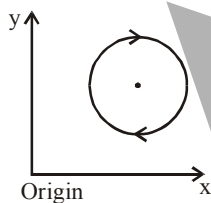
- (1) $+mv^2b\hat{k}$
(2) $-mvb\hat{k}$
(3) $-2mvb\hat{k}$
(4) $-mvb\hat{j}$



2. A simple pendulum of mass m and length L is held in horizontal position. If it is released from this position, then find the angular momentum of the bob about the point of suspension when it is vertically below the point of suspension.

- (1) $mL\sqrt{2gL}$ (2) $mL\sqrt{gL}$
(3) $mL\sqrt{3gL}$ (4) none of these

3. A particle is moving in circle with uniform speed as shown. The angular momentum of the particle w.r.t. origin is :-



- (1) Constant in magnitude only
(2) Constant in magnitude as well as direction
(3) Constant in direction only
(4) Variable in magnitude as well as direction
4. A particle is moving along a straight line with increasing speed. Its angular momentum about a fixed point on this line :-
- (1) Goes on increasing
(2) Goes on decreasing
(3) May be increasing or decreasing depending on direction of motion
(4) Remains zero

5. If radius of earth suddenly contracts by half of its initial value keeping mass constant, then what will be the time period of rotation of earth about its axis ?

- (1) 6hr (2) 12hr (3) 3hr (4) 4hr

6. Due to global warming, ice on polar caps is likely to melt in large quantity. Due to this effect :-

- (1) Moment of inertia of earth shall decrease
(2) Duration of the day shall decrease
(3) Angular velocity of earth shall decrease
(4) Angular momentum of earth shall decrease

7. A disc of mass 1 kg and radius 0.1 m is rotating with angular velocity 20 rad/s. What is angular velocity (in rad/s) if a mass of 0.5 kg is put on the circumference of the disc ?

- (1) 10 (2) 20 (3) 40 (4) 30

8. A metre stick is pivoted about its centre. A piece of wax of mass 20g travelling horizontally and perpendicular to it at 5 m/s strikes and adheres to one end of the stick so that the stick starts to rotate in a horizontal circle. Given the moment of inertia of the stick and wax about the pivot is 0.02 kg m^2 , the initial angular velocity of the stick is :-

- (1) 1.58 rad/s (2) 2.24 rad/s
(3) 2.50 rad/s (4) 5.00 rad/s

9. If two discs of moment of inertia I_1 and I_2 rotating about collinear axis passing through their centre of mass and perpendicular to their plane with angular speeds, ω_1 and ω_2 respectively in opposite directions. Now they are made to rotate combinedly along same axis, then the magnitude of angular velocity of the system is :-

- (1) $\frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}$ (2) $\frac{I_1\omega_1 - I_2\omega_2}{I_1 + I_2}$
(3) $\frac{I_1\omega_1 + I_2\omega_2}{\omega_1 + \omega_2}$ (4) $\frac{I_1\omega_1 - I_2\omega_2}{\omega_1 - \omega_2}$

10. A particle of mass m has been thrown with initial speed u making an angle θ with the horizontal ground. Find the angular momentum of the projectile about an axis perpendicular to the plane and passing through the point of projection when the projectile is :-
- (a) At the highest point
(b) About to hit the ground
11. An angular impulse of 20 Nms is applied to a hollow cylinder of mass 2 kg and radius 20 cm. The change in its angular speed is :-
- (1) 25 rad/s
(2) 2.5 rad/s
(3) 250 rad/s
(4) 2500 rad/s

ALLEN

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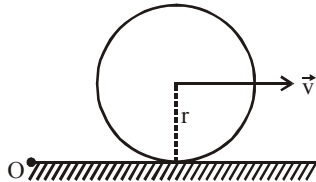
ANSWER KEY

- | | | | | |
|---|------|-------|------|------|
| 1. 2 | 2. 1 | 3. 4 | 4. 4 | 5. 1 |
| 6. 3 | 7. 1 | 8. 3 | 9. 2 | |
| 10. (a) $\frac{\mu^3 \sin^2 \theta \cos \theta}{2g}$ (b) $\frac{2\mu^3 \sin^2 \theta \cos \theta}{g}$ | | 11. 3 | | |

ROTATIONAL MOTION

RACE # 04

1. Figure shows a solid sphere rolling without slipping on a horizontal surface. Its radius is r , mass is m and the velocity of its centre is $\vec{v}$. Find the angular momentum about any point O on the horizontal surface along the line parallel to its velocity $\vec{v}$.



- (1) $\frac{7}{5} mvr$ (2) $\frac{5}{7} mvr$
- (3) $\frac{3}{7} mvr$ (4) none of these
2. Choose the correct statement.
- (1) A sphere can do pure rolling on smooth horizontal surface
- (2) A sphere can't do pure rolling on a fixed smooth wedge
- (3) Friction can act parallel or antiparallel to the direction of motion
- (4) All of these
3. A thin uniform circular ring is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the inclined plane is :-
- (1) g (2) $\frac{g}{2}$ (3) $\frac{g}{3}$ (4) $\frac{g}{4}$
4. Two solid spheres of different mass, radii and density roll down a rough inclined plane under identical situation. Their time to come down is independent of their :-
- (1) Mass (2) Radius
- (3) Density (4) All of these
5. A thin circular ring first slips down a smooth incline then rolls down a rough incline of identical geometry from same height. Ratio of time taken in the two motion is :-
- (1) $\frac{1}{2}$ (2) 1 (3) $\frac{1}{\sqrt{2}}$ (4) $\frac{1}{4}$

6. A solid sphere is rolling without slipping on a level surface at a constant speed of 2.0 ms^{-1} . How far can it roll up a 30° ramp before it stops? ($g = 10 \text{ m/s}^2$)
- (1) 56 cm (2) 26 cm
- (3) 53 cm (4) 84 cm
7. When a body is under pure rolling, the fraction of its total kinetic energy which is purely rotational is $\frac{2}{5}$. Identify the body.
- (1) Hollow sphere (2) Sphere
- (3) Ring (4) Disc
8. When a point mass slips down on a smooth incline from top, it reaches the bottom with linear speed v . If same mass is in the form of disc rolls down without slipping on a rough incline of identical geometry through same distance, what will be its linear velocity at the bottom ?
- (1) $v\sqrt{\frac{2}{3}}$ (2) $\sqrt{\frac{v}{3}}$
- (3) v (4) $\sqrt{\frac{2v}{3}}$
9. A solid cylinder rolls down without slipping on an inclined plane of angle of inclination θ . What should be the minimum value of coefficient of friction between cylinder and inclined surface for pure rolling motion.
- (1) $\frac{1}{3} \tan \theta$ (2) $\tan \theta$
- (3) $\frac{2}{3} \tan \theta$ (4) $3 \tan \theta$
10. A solid sphere rolls on horizontal surface without slipping. What is the ratio of its rotational to translation kinetic energy.
- (1) $\frac{2}{5}$ (2) $\frac{5}{2}$
- (3) $\frac{3}{2}$ (4) 0

11. Two discs having masses in the ratio 1 : 2 and radii in the ratio 1 : 8 roll down without slipping one by one from an inclined plane of height h . The ratio of their linear velocities on reaching the ground is :-

(1) 1 : 16 (2) 1 : 128
(3) 1 : $8\sqrt{2}$ (4) 1 : 1

12. Which of the following (if mass and radius are assumed to be same) have maximum percentage of total K.E. in rotational form while pure rolling?

(1) Disc (2) Sphere
(3) Ring (4) Hollow sphere

13. A solid cylinder of mass M and radius R rolls down on an inclined plane of height h . The angular velocity of the cylinder when it reaches the bottom of the plane will be :-

(1) $\frac{1}{2R}\sqrt{gh}$ (2) $\frac{2}{R}\sqrt{gh}$
(3) $\frac{2}{R}\sqrt{\frac{gh}{3}}$ (4) $\frac{2}{R}\sqrt{\frac{gh}{2}}$

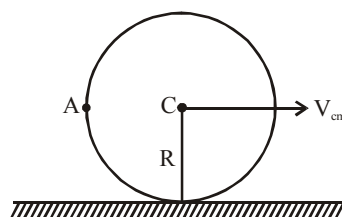
14. A solid sphere of diameter 0.1 m and mass 5 kg is rolling down an inclined plane with a speed of 4 m/s. The total kinetic energy of the sphere is :-

(1) 28 J (2) 56 J (3) 84 J (4) 112 J

15. The speed of a uniform solid cylinder after rolling down an inclined plane of vertical height H , from rest without sliding is :-

(1) $\sqrt{\frac{gH}{3}}$ (2) $\sqrt{\frac{2gH}{3}}$
(3) $\sqrt{gH}$ (4) $\sqrt{\frac{4gH}{3}}$

16. In case of pure rolling, what will be the velocity of point A of the ring of radius R ?



(1) V_{cm} (2) $\sqrt{2}V_{cm}$
(3) $\frac{V_{cm}}{2}$ (4) $2V_{cm}$

17. When a body is rolling without slipping on a rough horizontal surface, the work done by friction is :-

(1) Always zero (2) May be zero
(3) Always positive (4) Always negative

18. An inclined plane makes an angle of 30° with the horizontal. A solid sphere rolling down on this inclined plane from rest without slipping has a linear acceleration equal to :-

(1) $\frac{g}{3}$ (2) $\frac{2g}{3}$
(3) $\frac{5g}{7}$ (4) $\frac{5g}{14}$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	1	4	4	4	3	1	1	1	1	1	4	3	3	2	4
Que.	16	17	18												
Ans	2	1	4												

GRAVITATION

- Two particles of equal mass m go round a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is
 - $\frac{1}{2R}\sqrt{\frac{1}{Gm}}$
 - $\sqrt{\frac{Gm}{2R}}$
 - $\frac{1}{2}\sqrt{\frac{Gm}{R}}$
 - $\sqrt{\frac{4Gm}{R}}$
- A particle is projected vertically upwards from the surface of the earth (radius R_e) with a speed equal to one fourth of escape velocity. What is the maximum height attained by it from the surface of the earth ?
 - $\frac{16}{15}R_e$
 - $\frac{R_e}{15}$
 - $\frac{4}{15}R_e$
 - None of these
- Which of the following statements are true about acceleration due to gravity?
 - 'g' decreases when moving away from the centre if $r > R$
 - 'g' decreases when moving away from the centre if $r < R$
 - 'g' is zero at the centre of earth
 - 'g' decreases if earth stops rotating about its axis
 - (a) & (b)
 - (a), (b) & (c)
 - (a) & (c)
 - (a), (b) (c) & (d)
- The intensity of gravitational field at a point situated at a distance 8000 km from the centre of Earth is 6.0 newton /kg. The gravitational potential at that point in newton – meter/kg will be :-
 - 6
 - $- 4.8 \times 10^7$
 - $- 8 \times 10^5$
 - $- 4.8 \times 10^2$
- For a satellite to be geo-stationary, which of the following are essential conditions?
 - It must always be stationed above the equator
 - It must be rotated from west to east
 - It must be about 36000 km above the Earth surface
 - Its orbit must be circular, and not elliptical
 - (a) & (b)
 - (a), (b) & (c)
 - (c) & (d)
 - (a), (b), (c) & (d)
- If suddenly the gravitational force of attraction between earth and a satellite revolving around it becomes zero, then the satellite will-
 - continue to move in its orbit with same speed
 - move tangentially to the original orbit with same velocity
 - become stationary in its orbit
 - move towards the earth
- The kinetic energy needed to project a body of mass m from the earth's surface (radius R) to infinity is-
 - $\frac{mgR}{2}$
 - $2mgR$
 - mgR
 - $\frac{mgR}{4}$
- The change in the value of g at a height h above the surface of the earth is the same as at a depth d below the surface of earth. When both d and h are much smaller than the radius of earth, then which one of the following is correct ?
 - $d = \frac{h}{2}$
 - $d = \frac{3h}{2}$
 - $d = 2h$
 - $d = h$
- The height at which the acceleration due to gravity becomes $g/9$ (where g = acceleration due to gravity on the surface of the earth) in terms of R , (the radius of the earth) is :-
 - $\frac{R}{2}$
 - $\sqrt{2}R$
 - $2R$
 - $\frac{R}{\sqrt{2}}$

10. Two bodies of masses m and $4m$ are placed at a distance r . The gravitational potential at a point on the line joining them where the gravitational field is zero is :-

(1) $-\frac{6Gm}{r}$ (2) $-\frac{9Gm}{r}$
(3) zero (4) $-\frac{4Gm}{r}$

11. Gravitational force between two point masses m and M separated by a distance is F . Now if a point mass $2m$ is placed next to m in contact with it, the force on M due to m and the total force on M are :-

(1) $2F, F$ (2) $F, 2F$
(3) $F, 3F$ (4) F, F

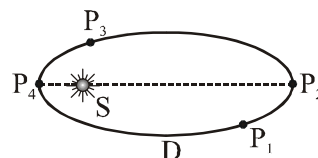
12. The height at which the acceleration due to gravity decreases by 36% of its value on the surface of the earth is: (Assume radius of the earth is R) :-

(1) $\frac{R}{4}$ (2) $\frac{R}{2}$
(3) $\frac{R}{6}$ (4) $4R$

13. A thin rod of length L is bent to form a semicircle. The mass of rod is M . What will be the gravitational potential at the centre of the circle?

(1) $-\frac{GM}{L}$ (2) $-\frac{GM}{2\pi L}$
(3) $-\frac{\pi GM}{2L}$ (4) $-\frac{\pi GM}{L}$

14. Figure shows a planet in an elliptical orbit around the sun S . At which place kinetic energy of the planet is maximum ?



(1) P_1 (2) P_2 (3) P_3 (4) P_4

15. When a body is taken from pole to the equator its weight :-

(1) Remains constant (2) Increases
(3) Decreases (4) None of these

16. The change in potential energy when a body of mass m is raised to a height nR from the earth's surface is: (R = radius of the earth)

(1) $mgR \frac{n}{(n-1)}$ (2) mgR
(3) $mgR \frac{n}{(n+1)}$ (4) $mgR \frac{n^2}{(n^2+1)}$

17. The variation in the speed of the planet in its orbit about the sun can be explained on the basis of the conservation of :-

(1) Angular kinetic energy
(2) Linear momentum
(3) Angular momentum
(4) None of these

18. Two satellites A and B go around a planet P in circular orbits having radius $4R$ and R respectively. If the speed of satellite A is $3v$, then the speed of satellite B will be :-

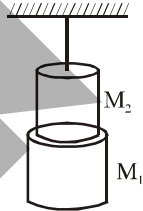
(1) $5v$ (2) $9v$
(3) $6v$ (4) none of these

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	3	2	3	2	4	2	3	3	3	2	3	1	4	4	3
Que.	16	17	18												
Ans	3	3	3												

Properties of Matter & Fluid Mechanics (Elasticity)

RACE # 01

- Wires A and B are made from the same material. A has twice the diameter and three times the length of B. If the elastic limits are not reached, when each is stretched by the same tension, the ratio of energy stored in A to that in B is :-
 (1) 2 : 3 (2) 3 : 4
 (3) 3 : 2 (4) 6 : 1
- The breaking stress for a wire of radius r of given material is $F \text{ N/m}^2$. The breaking stress for the wire of same material of radius $2r$ is :-
 (1) $F/4$ (2) $F/2$ (3) F (4) $2F$
- The bulk modulus of rubber is $9.1 \times 10^8 \text{ N/m}^2$. To what depth a rubber ball be taken in a lake so that its volume is decreased by 0.1%?
 ($g = 10 \text{ m/s}^2$)
 (1) 25m (2) 91m
 (3) 200 m (4) 500 m
- A solid sphere of radius R made of material of bulk modulus B is surrounded by a liquid in a cylindrical container. A massless piston of area A floats on the surface of the liquid. When a mass M is placed on the piston to compress the liquid, the fractional change in the radius of the sphere is :-
 (1) $\frac{Mg}{BA}$ (2) $\frac{Mg}{3BA}$
 (3) $\frac{3Mg}{4BA}$ (4) $\frac{Mg}{4BA}$
- If the pressure of fluid is increased from $1.01 \times 10^5 \text{ Pa}$ to $1.165 \times 10^5 \text{ Pa}$ and volume is decreased by 10% at constant temperature, then the bulk modulus of the fluid is :-
 (1) $15.5 \times 10^5 \text{ Pa}$ (2) $1.4 \times 10^5 \text{ Pa}$
 (3) $1.55 \times 10^5 \text{ Pa}$ (4) $0.0155 \times 10^5 \text{ Pa}$
- The rubber cord of a catapult has cross-section area 1 mm^2 and a total unstretched length 10 cm. It is stretched to 12 cm and then released to project a particle of mass 5 g. Calculate the velocity of projection (Y for rubber is $5 \times 10^8 \text{ N/m}^2$).
 (1) 5 ms^{-1}
 (2) 10 ms^{-1}
 (3) 20 ms^{-1}
 (4) 40 ms^{-1}
- The length of wire, when mass M_1 is hung from it, is l_1 and is l_2 with both masses M_1 and M_2 hanging. The natural length of wire is :-

 (1) $\frac{M_1}{M_2}(l_1 - l_2) + l_1$ (2) $\frac{M_2 l_1 - M_1 l_2}{M_1 + M_2}$
 (3) $\frac{l_1 + l_2}{2}$ (4) $\sqrt{l_1 l_2}$
- The Young's modulus of a wire of length L and radius r is Y newton per square metre. If the length is reduced to $L/2$ and radius to $r/2$, its Young's modulus will be :-
 (1) $\frac{Y}{2}$ (2) Y (3) $2Y$ (4) $4Y$
- When a mass of 5kg is hung on a wire then extension of 30 cm take place then work done will be :- ($g = 10 \text{ m/s}^2$)
 (1) 7.5 J (2) 15 J (3) 0.5 J (4) 1.5 J
- The Young's modulus of brass and steel are respectively $1 \times 10^{10} \text{ N/m}^2$ and $2 \times 10^{10} \text{ N/m}^2$. A brass wire and a steel wire of the same length are extended by 1 mm under the same force; the radii of brass and steel wires are R_B and R_S respectively. Then :-
 (1) $R_S = \sqrt{2}R_B$ (2) $R_S = \frac{R_B}{\sqrt{2}}$
 (3) $R_S = 4R_B$ (4) $R_S = \frac{R_B}{4}$

11. If ρ is the density of the material of a wire and σ is the breaking stress, the greatest length of the wire that can hang freely without breaking is:-
 (1) $\frac{2\sigma}{\rho g}$ (2) $\frac{\rho}{\sigma g}$ (3) $\frac{\rho g}{2\sigma}$ (4) $\frac{\sigma}{\rho g}$
12. The young's modulus of the material of a wire is $2 \times 10^{10} \text{ Nm}^{-2}$. If the longitudinal strain is 1% then the energy stored in the wire per unit volume is :-
 (1) $0.5 \times 10^6 \text{ Jm}^{-3}$ (2) 10^6 Jm^{-3}
 (3) $2 \times 10^6 \text{ Jm}^{-3}$ (4) $4 \times 10^6 \text{ Jm}^{-3}$
13. A cube of side 40 cm has its upper face displaced by 0.1 mm by a tangential force of 8 kN. The shearing modulus of cube is :-
 (1) $2 \times 10^9 \text{ N-m}^{-2}$ (2) $4 \times 10^9 \text{ N-m}^{-2}$
 (3) $2 \times 10^8 \text{ N-m}^{-2}$ (4) $4 \times 10^8 \text{ N-m}^{-2}$
14. The Bulk Modulus for an incompressible liquid is :-
 (1) zero (2) unity
 (3) infinity (4) between 0 and 1
15. A steel wire of cross-sectional area $3 \times 10^{-6} \text{ m}^2$ can withstand a maximum strain of 10^{-3} . Young's modulus of steel is $2 \times 10^{11} \text{ N/m}^2$. The maximum mass the wire can hold is:-
 (Take $g = 10 \text{ m/s}^2$)
 (1) 40 kg (2) 60 kg
 (3) 80 kg (4) 100 kg
16. The Young's modulus of the material of a wire is equal to the :-
 (1) stress required to increase its length four times
 (2) stress required to produce unit strain
 (3) strain produced in it
 (4) half the strain produced in it

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	3	2	2	3	3	1	2	1	2	4	2	3	3	2
Que.	16														
Ans.	2														

Properties of Matter & Fluid Mechanics (Fluid Dynamics + Viscosity)

RACE # 02

- Blood is flowing at the rate of $200 \text{ cm}^3/\text{sec}$ in a capillary of cross-sectional area 0.5 m^2 . The velocity of flow, (in mm/sec) is :-
(1) 0.1 (2) 0.2 (3) 0.3 (4) 0.4
- The cylindrical tube of a spray pump has a cross-section of 8 cm^2 , one end of which has 40 fine holes each of area 10^{-8} m^2 . If the liquid flows inside the tube with a speed of 0.15 m min^{-1} , the speed with which the liquid is ejected through the holes is :-
(1) 50 ms^{-1} (2) 5 ms^{-1}
(3) 0.05 ms^{-1} (4) 0.5 ms^{-1}
- A cylindrical vessel is filled with water upto a height of 92 cm. It has four holes 1,2,3 and 4 which are respectively at heights of 20cm, 30cm, 46cm and 80cm from the horizontal floor. The water falling at the maximum horizontal distance from the vessel comes from :-
(1) hole 4 (2) hole 3
(3) hole 2 (4) hole 1
- A cylindrical tank has a hole of 1 cm^2 in its bottom. If the water is allowed to flow into the tank from a tubes above it at the rate of $70 \text{ cm}^3/\text{sec}$ then the maximum height upto which water can rise in the tank is :-
(1) 2.5 cm (2) 5 cm (3) 10 cm (4) 0.25 cm
- Air is streaming past a horizontal aeroplane wing such that its speed is 120 metre per sec over the upper surface and 90 metre per sec at the lower surface. If the density of air is $1.3 \text{ kg per metre}^3$ and the wing is 10 metre long and has an average width of 2 metre, then the difference of the pressure on the two sides of the wing is :-
(1) 4095.0 pascal (2) 409.50 pascal
(3) 40.950 pascal (4) 4.0950 pascal
- An air bubble of 1 cm radius is rising at a steady rate of $2.00 \text{ mm}/\text{sec}$ through a liquid of density 1.5 gm per cm^3 . Neglect density of air. If g is $1000 \text{ cm}/\text{sec}^2$, then the coefficient of viscosity of the liquid is :-
(1) $0.166 \times 10^3 \text{ poise}$
(2) $166 \times 10^3 \text{ poise}$
(3) $1.66 \times 10^3 \text{ poise}$
(4) $16.6 \times 10^3 \text{ poise}$
- Sixty four spherical rain drops of equal size are falling vertically through air with a terminal velocity 1.5 ms^{-1} . If these drops coalesce to form a big spherical drop, then terminal velocity of big drop is :-
(1) 8 ms^{-1} (2) 16 ms^{-1}
(3) 24 ms^{-1} (4) 32 ms^{-1}
- A layer of glycerine of thickness 1 mm is present between a large surface and small surface of area 0.1 m^2 . With what force the small surface is to be pulled, so that it can move with a velocity of 1 m/s ?
(coefficient of viscosity = $0.07 \text{ kg}\cdot\text{m}^{-1}\text{s}^{-1}$)
(1) 70N (2) 7N
(3) 700 N (4) 0.70N
- Water contained in a tank flows through an orifice of diameter 2cm, under a constant pressure difference of 10 cm of water column. The rate of flow of water through the orifice is nearly equal to :-
(1) 44 cc/sec (2) 4.4 cc/sec
(3) 440 cc/sec (4) 4400 cc/sec
- A small ball of mass m and radius r is falling under gravity through a viscous liquid of coefficient of viscosity η . If g is the acceleration due to gravity then the terminal velocity of the ball is proportional to :-
(1) $\frac{mg\eta}{r}$ (2) $mg\eta r$ (3) $\frac{mgr}{\eta}$ (4) $\frac{mg}{r\eta}$

11. A sphere of brass released in a long liquid column attains a terminal velocity v_0 . If the terminal velocity attained by sphere of marble of the same radius and released in the same liquid is nv_0 . Then the value of n will be: (given the specific gravity of brass, marble and liquid are 8.5, 2.5 and 0.8 respectively.)
- (1) $\frac{5}{17}$ (2) $\frac{17}{77}$ (3) $\frac{11}{31}$ (4) $\frac{17}{5}$
12. A river 10 m deep is flowing at 5 ms^{-1} . The shearing stress between horizontal layers of the river is ($\eta = 10^{-3}$ SI units) :-
- (1) 10^{-3} N/m^2 (2) $0.8 \times 10^{-3} \text{ N/m}^2$
(3) $0.5 \times 10^{-3} \text{ N/m}^2$ (4) 1 N/m^2
13. Two metal spheres are falling through a liquid of density $2 \times 10^3 \text{ kg/m}^3$ with the same uniform speed. The material density of sphere 1 and sphere 2 are $8 \times 10^3 \text{ kg/m}^3$ and $11 \times 10^3 \text{ kg/m}^3$ respectively. The ratio of their radii is :-
- (1) $\frac{11}{8}$ (2) $\sqrt{\frac{11}{8}}$ (3) $\frac{3}{2}$ (4) $\sqrt{\frac{3}{2}}$
14. Water flows in a stream-line manner through a capillary tube of radius a . The pressure difference being P and the rate of flow is Q . If the radius is reduced to $a/2$ and the pressure is increased to $2P$, then the rate of flow becomes:-
- (1) $4Q$ (2) $2Q$
(3) Q (4) $Q/8$
15. A metal plate of area 10^3 cm^2 rests on a layer of oil 6 mm thick. A tangential force of 10^{-2} N is applied on it to move it with a constant velocity of 6 cm s^{-1} . The coefficient of viscosity of the liquid is :-
- (1) 0.1 poise (2) 0.5 poise
(3) 0.7 poise (4) 0.9 poise

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	2	2	1	1	3	3	2	3	4	2	3	4	4	1

Properties of Matter & Fluid Mechanics (Hydrostatics)

RACE # 03

1. A tank of height 5m is half filled with water then it is filled upto top with a liquid of density 0.85 g/cm^3 then total pressure at bottom due to the liquids will be –

(1) $1.85 \frac{\text{g-wt}}{\text{cm}^2}$ (2) $89.25 \frac{\text{g-wt}}{\text{cm}^2}$
(3) $462.5 \frac{\text{g-wt}}{\text{cm}^2}$ (4) $500 \frac{\text{g-wt}}{\text{cm}^2}$

2. Find the density of a block of wood that floats in water with 0.1 of its volume above water:-

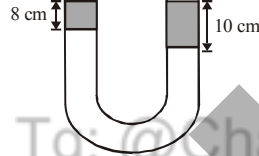
(1) 0.9 g/cc (2) 0.19 g/cc
(3) 0.1 g/cc (4) 0.15 g/cc

3. A liquid X of density 3.36 g/cm^3 is poured in a U-tube, which contains Hg. Another liquid Y is poured in left arm with height 8 cm. Upper levels of X and Y are same.

(Density of Hg = $13.6 \times 10^3 \text{ kg/m}^3$)

What is density of Y ?

(1) 0.8 gm/cc
(2) 1.2 gm/cc
(3) 1.4 gm/cc
(4) 1.6 gm/cc



4. A body of uniform cross-sectional area floats in a liquid of density thrice its value. The portion of exposed height will be:

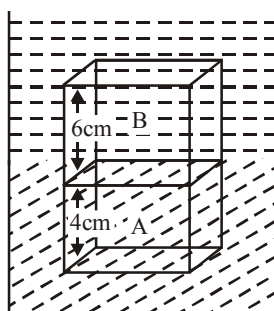
(1) $2/3$ (2) $5/6$ (3) $1/6$ (4) $1/3$

5. A cubical box of wood of side 30 cm and mass 21.6 kg floats on water with two faces horizontal. The length of immersed part in water is :-

($\rho_{\text{wood}} = 0.8 \text{ g/cc}$)

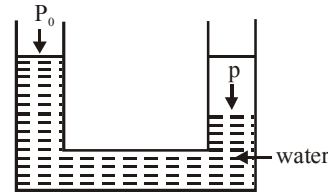
(1) 30 cm (2) 12 cm (3) 6 cm (4) 24 cm

6. A cube of edge length 10 cm is just balanced at the interface of two liquids A and B as shown in figure. If A and B has specific gravity 0.6 and 0.4 respectively, then mass of cube is :-



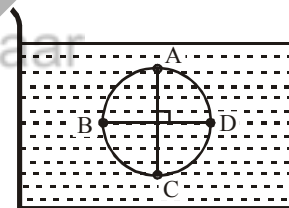
(1) 240 g (2) 360 g
(3) 480 g (4) 540 g

7. The pressure of confined air is p . If the atmospheric pressure is P_0 , then :-



- (1) P_0 is equal to p
(2) P_0 is less than p
(3) P_0 is greater than p
(4) P_0 may be less or greater than p depending on the mass of the confined air

8. Figure shows a container filled with a liquid of density ρ . Four points A, B, C and D lie on the diametrically opposite points of a circle as shown. Points A and C lie on vertical line and points B and D lie on horizontal line. The incorrect statement is (p_A, p_B, p_C, p_D are absolute pressure at the respective points) :-



(1) $p_D = p_B$
(2) $p_A < p_B = p_D < p_C$
(3) $p_D = p_B = \frac{p_C - p_A}{2}$
(4) $p_D = p_B = \frac{p_C + p_A}{2}$

9. A cubical block is floating in a liquid with one fourth of its volume immersed in the liquid. If whole of the system accelerates upward with acceleration $g/4$, the fraction of volume immersed in the liquid will be :-

(1) $1/4$ (2) $1/2$ (3) $3/4$ (4) $2/3$

10. A metallic sphere of mass 3 kg in air is held by a string so as to be completely immersed in a liquid of relative density 0.8. The relative density of metallic sphere is 10. The tension in the string is:- ($g = 10 \text{ m/s}^2$)

(1) 18.7 N (2) 42.5 N (3) 32.7 N (4) 27.6 N

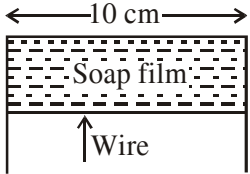
11. A cube made of material having a density of $0.9 \times 10^3 \text{ kg/m}^3$ floats between water and a liquid of density $0.7 \times 10^3 \text{ kg/m}^3$ which is immiscible with water. What part of the cube is immersed in water?
- (1) $\frac{1}{3}$ (2) $\frac{2}{3}$ (3) $\frac{3}{4}$ (4) $\frac{3}{7}$
12. The neck and bottom of a bottle are 3 cm and 15 cm in radius respectively. If the cork is pressed with a force 12 N in the neck of the bottle, then force exerted on the bottom of the bottle is :-
- (1) 30 N (2) 150 N (3) 300 N (4) 600 N
13. An open U-tube contains mercury. When 11.2 cm of water is poured into one of the arms of the tube, how high does the mercury rise in the other arm from its initial level?
- (1) 0.56 cm (2) 1.35 cm
(3) 0.41 cm (4) 2.32 cm
14. A block of wood floats in water with $\left(\frac{4}{5}\right)$ th of its volume submerged. If the same block just floats (completely immersed) in a liquid, the density of the liquid (in kg m^{-3}) is :-
- (1) 1250 (2) 600 (3) 400 (4) 800
15. Two spheres of volume 250 cc each but of relative densities 0.8 and 1.2 are connected by a string and the combination is immersed in a liquid. The tension in the string is:
- (g = 10 m/s^2)
- (1) 5.0 N (2) 0.5 N (3) 1.0 N (4) 2.0 N

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	1	1	1	4	3	2	3	1	4	2	3	3	4	2

Properties of Matter & Fluid Mechanics (Surface Tension)

RACE # 04

- Water rises to a height of 10 cm in a glass capillary tube. If the area of cross-section of the tube is reduced to one-fourth of its former value then find height of water rises in the tube.
(1) 20 cm (2) 5 cm
(3) 2.5 cm (4) 7 cm
 - A wire of mass 1gm is kept horizontally on the surface of water. The minimum length of the wire that does not break the surface film is :- (surface tension of water is 70 dyne cm^{-1})
(1) 3 cm (2) 4 cm
(3) 7 cm (4) 14 cm
 - The surface tension of two liquids are 30 dyne cm^{-1} and 60 dyne cm^{-1} respectively. The liquid drop form at the ends of two tube of the same radius. The ratio of the weight of the two drops is :-
(1) 1 : 2 (2) 1 : 3
(3) 2 : 3 (4) 3 : 4
 - Two vertical glass plates 1mm apart are dipped into water. How high will the water rise between the plates. If the surface tension of water is 70 dyne cm^{-1} .
(1) 1.43 cm (2) 1.63 cm
(3) 2.86 cm (4) 3.86 cm
 - The excess pressure due to surface tension inside a spherical drop is 6 unit. If eight such drops combine then the excess pressure due to surface tension inside the larger drop is :-
(1) 3 units (2) 6 units
(3) 12 units (4) 48 units
 - A soap film of surface tension $3 \times 10^{-2} \text{ N/m}$ formed in a rectangular frame can support a wire as shown in the figure. If $g = 10 \text{ ms}^{-2}$ then the mass of the wire is :-
(1) 0.006 g (2) 0.06 g
(3) 0.6 g (4) 6 g
- 
- Two soap bubbles one of radius 50 mm and the other of radius 80 mm are brought together so that they have a common interface.
(a) Determine the radius of curvature of this interface
(1) 114.6 mm (2) 125.6 mm
(3) 133.3 mm (4) 154.6 mm
(b) The radius of curvature of this interface attains which shape from smaller bubble towards larger bubble.
(1) Convex (2) Concave
(3) Plane (4) None of these
 - Liquid rises to a height of 2 cm in a capillary tube. The angle of contact between the solid and the liquid is zero. The tube is depressed more now so that the top of the capillary is only 1 cm above the liquid then the apparent angle of contact between the solid and the liquid is:-
(1) 0° (2) 30° (3) 60° (4) 90°
 - If a section of soap bubble (of radius R) through its centre is considered then force on one half due to surface tension is :-
(1) $2\pi RT$ (2) $4\pi RT$
(3) $\pi R^2 T$ (4) $\frac{4T}{R}$
 - What is the potential energy of the soap film formed on a frame of area $4 \times 10^{-3} \text{ m}^2$? (Surface tension = $40 \times 10^{-3} \text{ N/m}$.)
(1) $32 \times 10^{-5} \text{ J}$ (2) $16 \times 10^{-5} \text{ J}$
(3) $8 \times 10^{-5} \text{ J}$ (4) $16 \times 10^{-3} \text{ J}$
 - A frame made of metallic wire enclosing a surface area A is covered with a soap film. If the area of the frame of metallic wire is reduced by 50%, the energy of the soap film will be changed by :-
(1) 100% (2) 75% (3) 50% (4) 25%
 - The excess pressure inside one soap bubble is three times that inside a second soap bubble, then the ratio of their surface area is :-
(1) 1 : 9 (2) 1 : 3
(3) 3 : 1 (4) 1 : 27

13. The force required to lift a circular flat plate of radius 5 cm on the surface of water is: (Surface tension of water is 75 dyne/cm) :-
 (1) 30 dyne (2) 60 dyne
 (3) 750 dyne (4) 750π dyne
14. Find the difference of air pressure (in N-m^{-2}) between the inside and outside of a soap bubble 5 mm in diameter, if the surface tension is 1.6 N-m^{-1} .
 (1) 2560 (2) 3720
 (3) 1208 (4) 10132
15. The surface tension of soap solution is 0.03 N/m . The work done in blowing to form a soap bubble of surface area 40 cm^2 is :-
 (1) $1.2 \times 10^{-4} \text{ J}$ (2) $2.4 \times 10^{-4} \text{ J}$
 (3) $12 \times 10^{-4} \text{ J}$ (4) $24 \times 10^{-4} \text{ J}$
16. A 10 cm long wire is placed horizontally on the surface of water and is gently pulled up with a force of $2 \times 10^{-2} \text{ N}$. To keep the wire in equilibrium, the surface tension of water (in Nm^{-1}) is :-
 (1) 0.1 (2) 0.2 (3) 0.001 (4) 0.002
17. Work done in increasing the size of a soap bubble from a radius of 3 cm to 5 cm is nearly:- (Surface tension of soap solution = 0.03 Nm^{-1})
 (1) $4\pi \text{ mJ}$ (2) $0.2\pi \text{ mJ}$
 (3) $2\pi \text{ mJ}$ (4) $0.4\pi \text{ mJ}$
18. If T is the surface tension of a liquid, the energy needed to break a liquid drop of radius R into 64 drops is :-
 (1) $6\pi R^2 T$ (2) $\pi R^2 T$
 (3) $12\pi R^2 T$ (4) $8\pi R^2 T$

ANSWER KEY

Que.	1	2	3	4	5	6	7(a)	7(b)	8	9	10
Ans.	1	3	1	1	1	3	3	2	3	2	1
Que.	11	12	13	14	15	16	17	18			
Ans.	3	1	4	1	2	1	4	3			

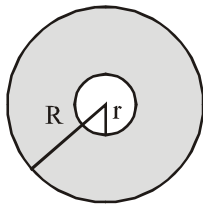
Thermal Physics (Temperature scales & thermal expansion)

RACE # 01

1. What is the temperature at which the Fahrenheit reading is double that of the Celsius reading ?

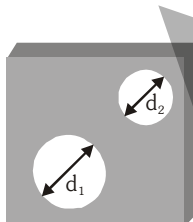
- (1) 320°F
(2) 300°F
(3) 373°F
(4) None

2. A circular metallic disc of radius R has a small circular cavity of radius r as shown in figure. On heating the system :



- (1) R increases and r decreases
(2) R decreases and r increases
(3) Both R and r increases
(4) Both R and r decreases

3. Two holes of unequal diameters d_1 and d_2 ($d_1 > d_2$) are cut in a metal sheet. If the sheet is heated

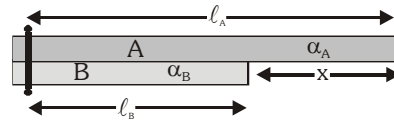


- (1) both d_1 and d_2 will decrease
(2) both d_1 and d_2 will increase
(3) d_1 will increase, d_2 will decrease
(4) d_1 will decrease, d_2 will increase

4. A beaker is completely filled with water at 4°C . It will overflow if

- (1) heated above 4°C
(2) cooled below 4°C
(3) both (1) & (2)
(4) none of the above

5. Bars of two different metals are bolted together, as shown in figure. The distance x does not change with temperature if



(1) $\frac{l_A}{l_B} = \frac{\alpha_A}{\alpha_B}$ (2) $\frac{l_A}{l_B} = \frac{\alpha_B}{\alpha_A}$

(3) $\frac{l_A^2}{l_B^2} = \frac{\alpha_A}{\alpha_B}$ (4) $\frac{l_A^2}{l_B^2} = \frac{\alpha_B}{\alpha_A}$

6. On a 'X' temperature scale, water freezes at -125.0°X and boils at 375.0°X . On a 'Y' temperature scale, water freezes at -70.0°Y and boils at -30.0°Y . The value of temperature on X-scale equal to the temperature of 50.0°Y on Y-scale is

- (1) 455.0°X (2) -125.0°X
(3) 1375.0°X (4) 1500.0°X

7. If celsius temperature scale shows temperature of air 30°C . Find the temperature of air in fahrenheit & kelvin.

- (1) 90°F , 303 K
(2) 86°F , 300 K
(3) 86°F , 303 K
(4) 90°F , 303 K

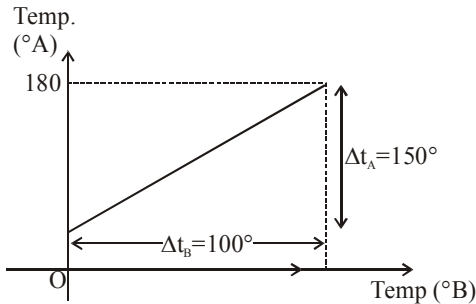
8. A glass thermometer is unmarked and has length of column $L_{100^{\circ}} = 60\text{ cm}$ $L_{0^{\circ}} = 10\text{ cm}$. If $L = 50\text{ cm}$, then temperature thermometer will be:-

- (1) 70°C (2) 80°C
(3) 90°C (4) 100°C

9. Two thermometers 'X' & 'Y' shows boiling point & freezing point of water as 220°X & 20°X and 120°Y & -40°Y respectively. If 'X' shows 100°X , then find the reading in 'Y' thermometer.

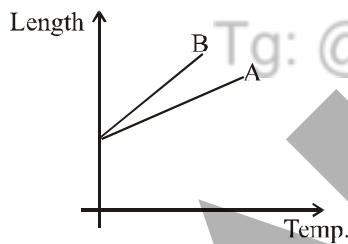
- (1) 25°Y (2) 50°Y
(3) 20°Y (4) 24°Y

10. The graph between two temperature scales A & B is shown between upper fixed point and lower fixed point. There are 150 divisions on scale A and 100 divisions on scale B. Then, relationship for conversion between two scales is given by:-



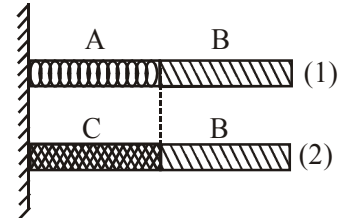
(1) $\frac{t_A - 180}{100} = \frac{t_B}{150}$ (2) $\frac{t_A - 30}{150} = \frac{t_B}{100}$
 (3) $\frac{t_A - 180}{150} = \frac{t_A}{100}$ (4) $\frac{t_B - 40}{100} = \frac{t_A}{180}$

11. Length v/s Temperature graph of A & B is given below. Find the relation between α_A & α_B .



(1) $\alpha_A > \alpha_B$ (2) $\alpha_A = \alpha_B$
 (3) $\alpha_A < \alpha_B$ (4) can't say

12. Two composite rods are made by A & B and C & B materials as shown. When we increase the temperature by ΔT , relation between final lengths of rod becomes $L_1 < L_2$. Find the relation between α_A and α_C .



(1) $\alpha_A > \alpha_C$ (2) $\alpha_A = \alpha_C$
 (3) $\alpha_A < \alpha_C$ (4) $\alpha_A + \alpha_C = \alpha_B$

13. A liquid with coefficient of volume expansion γ is filled in a container of material having coefficient of linear expansion α . If liquid overflows on heating then.

(1) $\gamma = 3\alpha$ (2) $\gamma > 3\alpha$
 (3) $\gamma < 3\alpha$ (4) $\gamma > 3\alpha^2$

14. The apparent coefficient of expansion of a liquid when heated in a copper vessel is C and when heated in a silver vessel is S. If A is the coefficient of linear expansion of copper, the coefficient of linear expansion of silver is :-

(1) $\frac{C+S-3A}{3}$ (2) $\frac{C+3A-S}{3}$
 (3) $\frac{S+3A-C}{3}$ (4) $\frac{C+S+3A}{3}$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Ans	1	3	2	3	2	3	3	2	4	2	3	3	2	2	

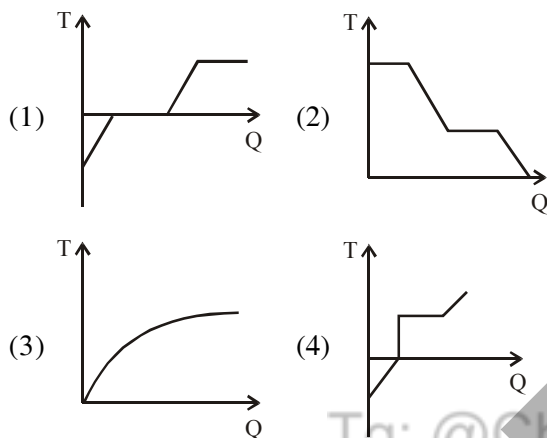
Thermal Physics (Calorimetry)

RACE # 02

1. Liquids A and B are at 30°C and 20°C . When equal masses are mixed the temperature of the mixture is found to be 26°C . Their specific heats are in the ratio of :-

(1) 3 : 2 (2) 1 : 1
(3) 2 : 3 (4) 4 : 3

2. A block of ice at -12°C is slowly heated and converted into steam at 100°C . Which of the following curves best represents the event ?



3. The water equivalent of 20 g of aluminium (specific heat $0.2 \text{ cal/g}^{\circ}\text{C}$), is :-

(1) 40 g (2) 4 g (3) 8 g (4) 160 g

4. 100 g of ice (latent heat 80 cal/g , at 0°C) is mixed with 100 g of water (specific heat $1 \text{ cal/g}^{\circ}\text{C}$) at 80°C . The final temperature of the mixture will be :-

(1) 0°C (2) 40°C (3) 80°C (4) $< 0^{\circ}\text{C}$

5. If 10 g of ice at 0°C is mixed with 10 g of water at 40°C . The final mass of water in mixture is (Latent heat of fusion of ice = 80 cal/g ; specific heat of water = $1 \text{ cal/g}^{\circ}\text{C}$)

(1) 10 g (2) 15 g
(3) 18 g (4) 20 g

6. A 10 g ice cube is dropped into 45 g of water kept in a glass. If the water was initially at a temperature of 28°C and the temperature of ice -15°C , find the final temperature (in $^{\circ}\text{C}$) of water.

(Specific heat of ice = $0.5 \text{ cal/g}^{\circ}\text{C}$ and $L = 80 \text{ cal/g}$)

(1) 14 (2) 7 (3) 28 (4) None

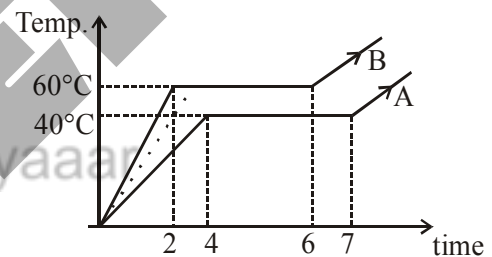
7. 2g ice at 0°C is mixed with 1g steam at 100°C . Find the final temperature of the mixture.

(1) 0°C (2) 50°C
(3) 100°C (4) $> 100^{\circ}\text{C}$

8. Steam at 100°C is passed into 22g of water at 20°C . The mass of water that will be present when the water acquires a temperature of 90°C (Latent heat of steam is 540 cal/g) is

(1) 24.8 gm (2) 24 gm
(3) 36.6 gm (4) 30 gm

9. In figure given two solid A and B of same mass are heated at constant rate by same source then find



(i) ratio of latent heat for fusion $\left(\frac{L_A}{L_B} \right)$

(1) $\frac{3}{4}$ (2) $\frac{4}{3}$ (3) $\frac{5}{3}$ (4) $\frac{3}{5}$

(ii) ratio of specific heat for solid state $\left(\frac{S_A}{S_B} \right)$

(1) $\frac{1}{3}$ (2) 3 (3) 6 (4) $\frac{1}{6}$

10. Ice at -20°C mixed with 200g water at 25°C . If temperature of mixture is 10°C then mass of ice is -

(1) 30 gm (2) 20 gm
(3) 15 gm (4) 40 gm

11. Calculate the time required to heat 20 kg of water from 10°C to 35°C using an immersion heater rated 1000 W. Assume that 80% of the power input is used to heat the water. Specific heat capacity of water = $4200 \text{ J/kg}\cdot\text{K}$
- (1) 40 min (2) 44 min
(3) 36 min (4) 48 min
12. Two tanks A and B contain water at 30°C and 80°C respectively. The amount of water that must be taken from A and B to prepare 40 kg water at 50°C .
- (1) 24 kg, 16 kg (2) 16 kg, 24 kg
(3) 20 kg, 20 kg (4) 30 kg, 10 kg

Tg: @Chalnaayaaar

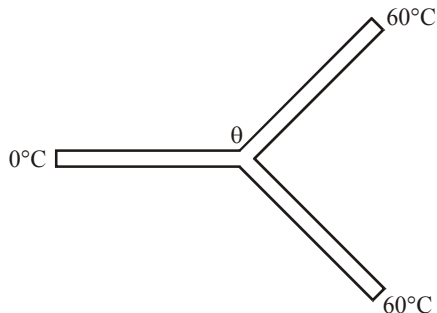
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11
Ans	1	1	2	1	2	2	3	1	(i)-1, (ii)-2	1	2
Que.	12										
Ans	1										

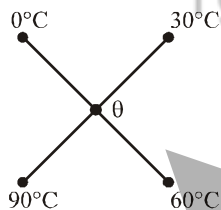
Thermal Physics (Modes of Heat Transfer)

RACE # 03

1. Three identical rods have been joined at a junction to make it a Y shape structure. If two free ends are maintained at 60°C and the third end is at 0°C , then what is the junction temperature θ ?



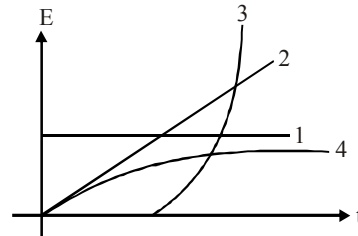
- (1) 40°C (2) 50°C
(3) 30°C (4) 60°C
2. Four rods of same material and having the same cross section and length have been joined, as shown. The temperature of the junction of four rods will be :



- (1) 20°C (2) 30°C
(3) 45°C (4) 60°C
3. Two electric lamps A and B radiate the same power. Their filaments have the same dimensions, and have emissivities e_A and e_B . Their surface temperatures are T_A and T_B . The ratio $\frac{T_A}{T_B}$ will be equal to

- (1) $\left(\frac{e_B}{e_A}\right)^{1/4}$ (2) $\left(\frac{e_B}{e_A}\right)^{1/2}$
(3) $\left(\frac{e_A}{e_B}\right)^{1/2}$ (4) $\left(\frac{e_A}{e_B}\right)^{1/4}$

4. A ball of surface temperature T is in thermal equilibrium with its environment. Which of the curve gives the radiating power E radiated by the sphere as a function of time ' t '?



- (1) 1 (2) 2 (3) 3 (4) 4
5. Two stars emit maximum radiation at wavelength $3600 \text{ \AA}$ and $4800 \text{ \AA}$ respectively. The ratio of their temperatures is—
(1) 1 : 2 (2) 3 : 4 (3) 4 : 3 (4) 2 : 1
6. **Statement-1** : Animals curl into a ball, when they feel very cold.
and
Statement-2 : Animals by curling their body reduces the surface area.
- (1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is not a correct explanation for Statement-1.
(3) Statement-1 is True, Statement-2 is False.
(4) Statement-1 is False, Statement-2 is True.
7. A heated body maintained at $T \text{ K}$ emits thermal radiation of total energy E with a maximum intensity at frequency ν . The emissivity of the material is 0.5. If the temperature of the body be increased and maintained at temperature $3T \text{ K}$, then :-
(i) The maximum intensity of the emitted radiation will occur at frequency $\nu/3$
(ii) The maximum intensity of the emitted radiation will occur at frequency 3ν .
(iii) The total energy of emitted radiation will become $81 E$
(iv) The total energy of emitted radiation will become $27 E$
(1) (i) & (ii) (2) (ii) & (iii)
(3) (i) & (iv) (4) (i), (ii) & (iv)

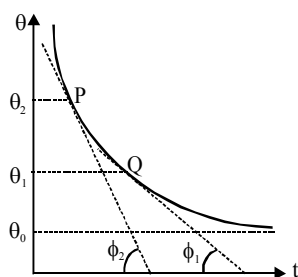
8. A body cools in a surrounding which is at a constant temperature of θ_0 . Assume that it obeys Newton's law of cooling. Its temperature θ is plotted against time t . Tangents are drawn to the curve at the points $P(\theta = \theta_2)$ and $Q(\theta = \theta_1)$. These tangents meet the time axis at angles of ϕ_2 and ϕ_1 , as shown

(1) $\frac{\tan \phi_2}{\tan \phi_1} = \frac{\theta_1 - \theta_0}{\theta_2 - \theta_0}$

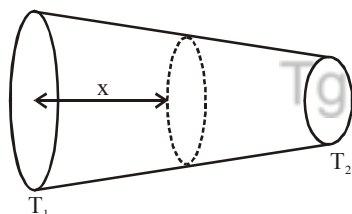
(2) $\frac{\tan \phi_2}{\tan \phi_1} = \frac{\theta_2 - \theta_0}{\theta_1 - \theta_0}$

(3) $\frac{\tan \phi_1}{\tan \phi_2} = \frac{\theta_1}{\theta_2}$

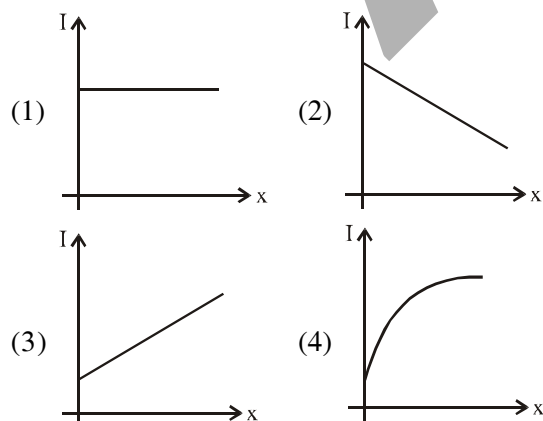
(4) $\frac{\tan \phi_1}{\tan \phi_2} = \frac{\theta_2}{\theta_1}$



9. Two ends of a rod of non uniform area of cross-section are maintained at temperature T_1 and T_2 ($T_1 > T_2$) as shown in the figure.

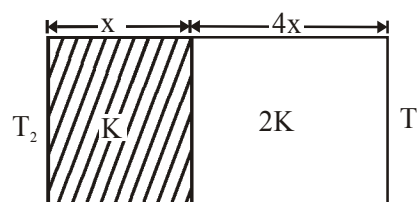


If I is heat current through the cross-section of conductor at distance x from its left face, then the variation of I with x is best represented by :



10. The temperature of the two outer surfaces of a composite slab, consisting of two materials having coefficients of thermal conductivity K and $2K$ and thickness x and $4x$, respectively are T_2 and T_1 ($T_2 > T_1$). The rate of heat transfer through the slab, in a steady state is

$\left[\frac{A(T_2 - T_1)K}{x} \right] f$, with f equal to :-



- (1) 1 (2) $\frac{1}{2}$ (3) $\frac{2}{3}$ (4) $\frac{1}{3}$

11. Suppose the sun expands so that its radius becomes 100 times its present radius and its surface temperature becomes half of its present value. The total energy emitted by it will become :

- (1) 10^4 times (2) 625 times
(3) 256 times (4) 16 times

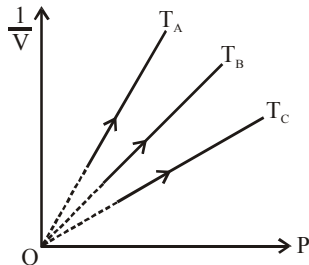
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11
Ans	1	3	1	1	3	1	2	2	1	4	2

Thermal Physics (Kinetic theory of gases)

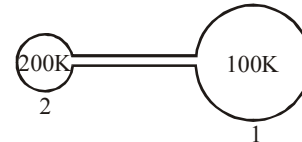
RACE # 04

1. Figure shows the isotherms of fixed mass of an ideal gas at three temperatures T_A , T_B and T_C then.



- (1) $T_A > T_B > T_C$ (2) $T_A < T_B < T_C$
 (3) $T_B < T_A < T_C$ (4) $T_A = T_B = T_C$
2. The pressure (P) and absolute temperature (T) of an ideal gas are related to each other as $P \propto \frac{1}{T^2}$. If temperature of gas is 300 K and its volume changes from V to 8 V, then find the final temperature of gas.
 (1) 600 K (2) 300 K
 (3) 373 K (4) 273 K
3. Four molecules of a gas have speeds 1, 2, 3 and 4 km/s. The value of the r.m.s. speed of the gas molecule is :-
 (1) $\frac{1}{2}\sqrt{15}$ km/s (2) $\frac{1}{2}\sqrt{10}$ km/s
 (3) 2.5 km/s (4) $\sqrt{\frac{15}{2}}$ km/s
4. If hydrogen gas is heated to a very high temperature, then the fraction of energy possessed by gas molecules correspond to rotational motion :-
 (1) $\frac{3}{5}$ (2) $\frac{2}{7}$
 (3) $\frac{3}{7}$ (4) $\frac{2}{5}$
5. The rms speed of helium gas at 27°C and 1 atm pressure is 900 ms^{-1} . Then the rms speed of helium molecules at temperature 27°C and 2 atm pressure is
 (1) 450 m/s (2) 900 m/s
 (3) 1800 m/s (4) 750 m/s

6. Figure shows two flasks connected to each other. The volume of the flask 1 is twice that of flask 2. The system is filled with an ideal gas at temperature 100 K and 200 K respectively in the flasks. If the mass of the gas in 1 be m, then what is the mass of the gas in flask 2 in equilibrium?



- (1) m (2) $\frac{m}{2}$ (3) $\frac{m}{4}$ (4) $\frac{m}{8}$
7. One mole of a diatomic gas undergoes a process $P = \frac{P_0}{1 + \left(\frac{V}{V_0}\right)^3}$, where P_0 , V_0 are constants. The translational kinetic energy of the gas when $V = V_0$ is given by
 (1) $\frac{5P_0V_0}{4}$ (2) $\frac{3P_0V_0}{4}$
 (3) $\frac{3P_0V_0}{2}$ (4) $\frac{5P_0V_0}{2}$
8. An ideal gas has an initial pressure of 3 pressure units and an initial volume of 4 volume units. The table gives the final pressure and volume of the gas (in those same units) in four processes. Which state lies on the same isotherm

	A	B	C	D
P	5	4	12	6
V	7	6	1	3

- (1) A (2) B
 (3) C (4) D

9. **Statement-1** : At low pressure and high temperature real gas approaches the ideal gas behaviour.

and

Statement-2 : At low pressure and high temperature the molecules are far apart and molecular interactions are negligible.

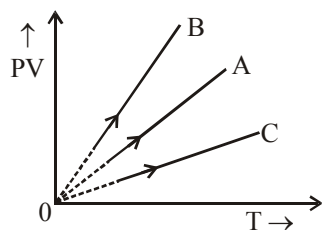
(1) Statement-1 is true, Statement-2 is true ;
Statement-2 is a correct explanation for Statement-1

(2) Statement-1 is true, Statement-2 is true,
Statement-2 is NOT a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

10. PV versus T graph of equal masses of H_2 , He and O_2 is shown in figure. Choose the correct alternative.



(1) A corresponds to He, B to H_2 and C to O_2

(2) A corresponds to H_2 , B to He and C to O_2

(3) A corresponds to He, B to O_2 and C to H_2

(4) A corresponds to O_2 , B to H_2 and C to He

11. At 20°C temperature, an argon gas at atmospheric pressure is confined in a vessel with a volume of 1m^3 . The effective hard-sphere diameter of argon atom is $3.10 \times 10^{-10}\text{m}$. Its mean free path is :

(1) 100 nm

(2) 90 nm

(3) 93.6 nm

(4) 95 nm

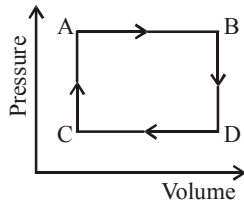
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	
Ans	2	1	4	2	2	3	2	3	1	1	3	

Thermal Physics (Thermodynamic process)

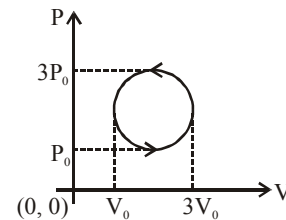
RACE # 05

1. The pressure and volume of gas are changed as shown in the P-V diagram in the figure ahead. The temperature of the gas :

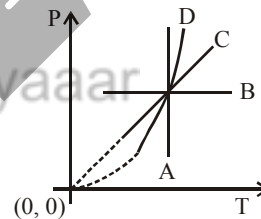


- (1) Increases as it goes from A to B
(2) Increases as it goes from B to C
(3) Remains constant during these changes
(4) Decreases as it goes from D to A
2. The efficiency of a Carnot's engine at a particular source and sink temperature is $\frac{1}{2}$. When the sink temperature is reduced by 100°C , the engine efficiency, becomes $\frac{2}{3}$. Find the source temperature.
(1) 600 K (2) 300 K (3) 373 K (4) None
3. An ideal refrigerator runs between -23°C and 27°C . Find the heat rejected to atmosphere for every joule of work input.
(1) 6 J (2) 5 J (3) 4 J (4) 3 J
4. Select the incorrect relation. (Where symbols have their usual meanings) :-
(1) $C_p = \frac{\gamma R}{\gamma - 1}$ (2) $C_p - C_v = R$
(3) $\Delta U = \frac{P_f V_f - P_i V_i}{1 - \gamma}$ (4) $C_v = \frac{R}{\gamma - 1}$
5. Select the incorrect statement about the specific heat of a gaseous system :
(1) Specific heat at no heat exchange condition, $C_A = 0$
(2) Specific heat at constant temperature, $C_T = \infty$
(3) Specific heat at constant pressure, $C_p = \frac{\gamma R}{\gamma - 1}$
(4) Specific heat at constant volume, $C_v = \frac{R}{\gamma}$

6. Work done in the cyclic process shown in figure is :-



- (1) $4P_0 V_0$ (2) $-4P_0 V_0$
(3) $-\frac{22}{7}P_0 V_0$ (4) $-13P_0 V_0$
7. Following figure shows P-T graph for four processes A, B, C and D. Select the correct alternative



- (1) A-Isobaric process (2) B-Adiabatic process
(3) C-Isochoric process (4) D-Isothermal process
8. The specific heat of a gas in a polytropic process ($PV^x = \text{constant}$) is given by :
(1) $C_v + \frac{R}{1+x}$ (2) $C_p + \frac{R}{1+x}$
(3) $C_v + \frac{R}{1-x}$ (4) $C_p + \frac{R}{1-x}$
9. For a certain process pressure of one mole diatomic gas varies according to the relation " $P = aV^2$ ", where a is constant. What is the molar heat capacity of the gas for this process ?
(1) $\frac{17R}{6}$ (2) $\frac{6R}{17}$ (3) $\frac{13R}{6}$ (4) $\frac{16R}{7}$

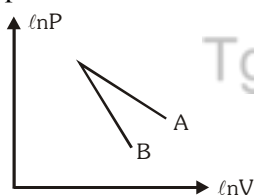
10. The temperature inside and outside a refrigerator are 273 K and 300 K respectively. Assuming that the refrigerator cycle is reversible. For every joule of work done heat delivered to the surrounding will be nearly :-

- (1) 11 J (2) 22 J
(3) 33 J (4) 50 J

11. A box of negligible mass containing 2 moles of an ideal gas of molar mass M and adiabatic exponent γ moves with constant speed v on a smooth horizontal surface. If the box suddenly stops, then change in temperature of gas will be :

- (1) $\frac{(\gamma-1)Mv^2}{4P}$ (2) $\frac{\gamma Mv^2}{2R}$
(3) $\frac{Mv^2}{2(\gamma-1)R}$ (4) $\frac{(\gamma-1)Mv^2}{2R}$

12. Two ideal gases A & B undergoing through adiabatic process. Choose the correct option.



- (1) both A & B are monoatomic
(2) both A & B are diatomic
(3) B is diatomic, A is monoatomic
(4) B is monoatomic, A is diatomic

13. One mole of hydrogen, assumed to be ideal, is adiabatically expanded from its initial state (P_1, V_1, T_1) to the final state (P_2, V_2, T_2) . The decrease in the internal energy of the gas during this process will be given by

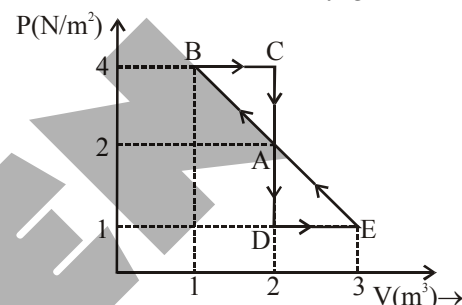
- (1) $C_v (T_1 - T_2)$ (2) $C_p (T_1 - T_2)$
(3) $\frac{C_p + C_v}{2} (T_1 - T_2)$ (4) $(C_p - C_v) (T_1 - T_2)$

14. One mole of an ideal gas undergoes a process whose molar heat capacity is $4R$ and in which work done by gas for small change in temperature is given by the relation $dW = 2RdT$,

then the ratio $\frac{C_p}{C_v}$ is

- (1) $\frac{7}{5}$ (2) $\frac{5}{3}$ (3) $\frac{3}{2}$ (4) 2

15. One mole of a monoatomic gas is carried along process ABCDEA as shown in the diagram. Find the net work done by gas :-



- (1) $\frac{3}{2}J$ (2) 1J (3) $\frac{1}{2}J$ (4) 0J

16. One mole of an ideal monoatomic gas at temperature ' T_0 ' expands according to the law $P = KV$, where K is a constant. If the final temperature of the gas is $2T_0$, Find the heat supplied to the gas :

- (1) $\frac{RT_0}{2}$ (2) RT_0 (3) $2RT_0$ (4) $\frac{3}{2}RT_0$

17. A Carnot engine is made to work first between 200°C & 0°C and then between 0°C & -200°C .

The ratio of efficiency $\left(\frac{\eta_2}{\eta_1}\right)$ of the engine in two

cases is :

- (1) 1 : 15 (2) 1 : 1 (3) 1 : 2 (4) 1.73 : 1

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	1	1	1	3	4	3	3	3	1	1	4	4	1	3	3
Que.	16	17													
Ans	3	4													

Oscillations (Kinematics of SHM)

RACE # 01

1. Two particles executing SHM of same frequency and same amplitude meet at $x = +\frac{\sqrt{3}A}{2}$, while moving in opposite directions. Phase difference between the particles is :-

(1) $\frac{\pi}{6}$ (2) $\frac{\pi}{3}$ (3) $\frac{5\pi}{6}$ (4) $\frac{2\pi}{3}$

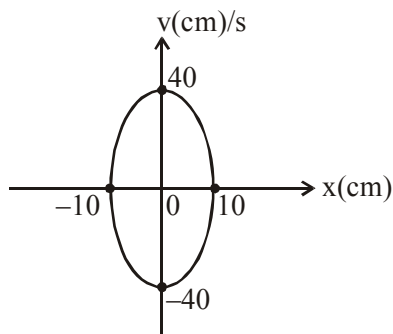
2. A particle is executing SHM with time period T Starting from mean position, time taken by it to complete $\frac{5}{8}$ oscillations is,

(1) $\frac{T}{12}$ (2) $\frac{T}{6}$ (3) $\frac{5T}{12}$ (4) $\frac{7T}{12}$

3. A particle executes simple harmonic motion according to equation $4\frac{d^2x}{dt^2} + 320x = 0$. Its time period of oscillation is :-

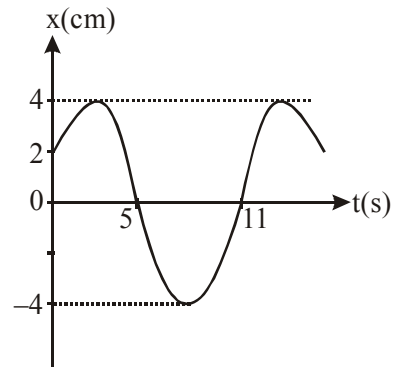
(1) $\frac{2\pi}{5\sqrt{3}}s$ (2) $\frac{\pi}{3\sqrt{2}}s$
(3) $\frac{\pi}{2\sqrt{5}}s$ (4) $\frac{2\pi}{\sqrt{3}}s$

4. The plot of velocity (v) versus displacement (x) of a particle executing simple harmonic motion is shown in figure. The time period of oscillation of particle is :-



(1) $\frac{\pi}{2}s$ (2) πs (3) $2\pi s$ (4) $3\pi s$

5. Figure shows the position-time graph of an object in SHM. The correct equation representing motion is :-



(1) $2\sin\left(\frac{2\pi}{5}t + \frac{\pi}{6}\right)$
(2) $4\sin\left(\frac{\pi}{5}t + \frac{\pi}{6}\right)$
(3) $4\sin\left(\frac{\pi}{6}t + \frac{\pi}{3}\right)$
(4) $4\sin\left(\frac{\pi}{6}t + \frac{\pi}{6}\right)$

6. A particle executes SHM according to equation $x = 10(\text{cm}) \cos\left[2\pi t + \frac{\pi}{2}\right]$, where t is in seconds. The magnitude of the velocity of the particle at $t = \frac{1}{6}s$ will be :-

(1) 24.7 cm/s (2) 20.5 cm/s
(3) 28.3 cm/s (4) 31.4 cm/s

7. A particle of mass m in a unidirectional potential field have potential energy $U(x) = \alpha + 2\beta x^2$, where α and β are positive constants. Find its time period of oscillations.

(1) $2\pi\sqrt{\frac{2\beta}{m}}$ (2) $2\pi\sqrt{\frac{m}{2\beta}}$
(3) $\pi\sqrt{\frac{m}{\beta}}$ (4) $\pi\sqrt{\frac{\beta}{m}}$

8. A particle executing S.H.M. has angular frequency 6.28 s^{-1} and amplitude 10 cm find (a) the time period (b) the maximum speed (c) the maximum acceleration (d) the speed when the displacement is 6 cm from the mean position (e) the speed at $t = 1/6 \text{ s}$. Assume that the motion starts from rest at $t = 0$ & $x = A$.
9. A body makes angular SHM of amplitude $\frac{\pi}{10}$ rad. and time period 0.05 s . If the body is at displacement $\theta = \frac{\pi}{10}$ rad. at $t = 0$, then write the equation giving the angular displacement as a function of time
10. The vertical motion of a ship at sea is described by the equation $\frac{d^2x}{dt^2} = -4x$, where x is the vertical height of the ship (in metre) above its mean position. If it oscillates through a height of 1 m then find maximum vertical speed and maximum vertical acceleration.
11. The phase difference between two SHMs $Y_1 = 10\sin(10\pi t + \pi/3)$ and $Y_2 = 12\sin(8\pi t + \pi/4)$ at $t = 0.5 \text{ s}$ is ____ :-
12. A small mass executes linear SHM about O with amplitude a and period T . Its displacement from O at time $T/8$ after passing through O is :-
(1) $\frac{a}{8}$ (2) $\frac{a}{2\sqrt{2}}$ (3) $\frac{a}{2}$ (4) $\frac{a}{\sqrt{2}}$
13. In SHM, the phase difference between the displacement and acceleration is :-
(1) 0 (2) $\pi/2$ (3) π (4) 2π
14. The acceleration of a particle moving along x-axis is $a = -100x + 50$. It is released from $x = 2$. Here 'a' and 'x' are in S.I units. The motion of particle will be :-
(1) periodic, oscillatory but not SHM
(2) periodic but not oscillatory
(3) oscillatory but not periodic
(4) simple harmonic
15. The acceleration of a certain simple harmonic oscillator is given by
 $a = -(35.28 \text{ m/s}^2) \cos 4.2t$
The amplitude of the simple harmonic motion is
(1) 2.0 m (2) 8.4 m
(3) 16.8 m (4) 17.64 m

ANSWERS

1. 2 2. 4 3. 3 4. 1 5. 4 6. 4 7. 3

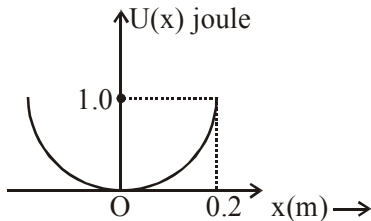
8. $[1\text{s}, 0.628 \frac{\text{m}}{\text{s}}, 4 \frac{\text{m}}{\text{s}^2}, 50.2 \frac{\text{cm}}{\text{s}}, -54.4 \frac{\text{cm}}{\text{s}}]$ 9. $[\theta = \frac{\pi}{10} \cos 40\pi t]$ 10. $[2 \text{ m/s}, -4 \text{ m/s}^2]$

11. 195° 12. 4 13. 3 14. 4 15. 1

Oscillations (Energy & spring pendulum)

RACE # 02

- If particle is executing simple harmonic motion with time period T , then the time period of its total mechanical energy is :-
(1) Zero (2) $T/2$ (3) $2T$ (4) Infinite
- A particle of mass 4 kg moves simple harmonically such that its PE (U) varies with position x , as shown. The period of oscillations is :-



- (1) $\frac{2\pi}{25}\text{ s}$ (2) $\frac{\pi\sqrt{2}}{5}\text{ s}$ (3) $\frac{4\pi}{5}\text{ s}$ (4) $\frac{2\pi\sqrt{2}}{5}\text{ s}$
- When a mass m attached to a spring it oscillates with period 4 s . When an additional mass of 2 kg is attached to a spring, time period increases by 1 s . The value of m is :-
(1) 3.5 kg (2) 8.2 kg (3) 4.7 kg (4) 2.6 kg
- $F-x$ and $x-t$ graph of a particle in SHM are as shown in figure match the following

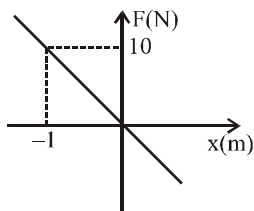


Table-1

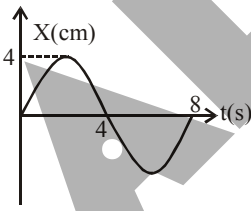
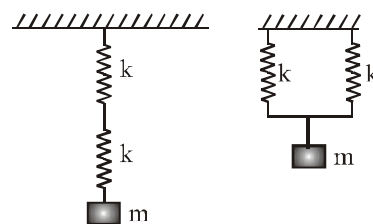


Table-2

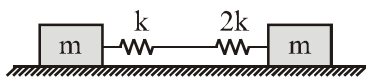
- Mass of the particle (p) $\frac{\pi}{2}$ SI unit
 - Maximum kinetic energy of particle (q) $\left(\frac{160}{\pi^2}\right)$ SI units
 - Angular frequency of particle (r) (8.0×10^{-3}) SI unit
 - (s) None
- A linear harmonic oscillator of force constant $2 \times 10^6\text{ Nm}^{-1}$ and amplitude 0.01 m has a total mechanical energy of 160 J . Its :-
(1) maximum potential energy is 100 J
(2) maximum kinetic energy is 100 J
(3) maximum potential energy is 160 J
(4) maximum potential energy is zero

- A particle is moving on x -axis has potential energy $U = 2 - 20x + 5x^2$ joules. The particle is released at $x = -3$. The maximum value of ' x ' will be [x is in meters and U is in joules]:-
(1) 5 m (2) 3 m (3) 7 m (4) 8 m
- The potential energy of a particle executing SHM changes from maximum to minimum in 5 s . Then the time period of SHM is :-
(1) 5 s (2) 10 s (3) 15 s (4) 20 s
- A particle of mass m performs SHM along a straight line with frequency f and amplitude A :-
(1) The average kinetic energy of the particle is zero
(2) The average potential energy is $m\pi^2 f^2 A^2$
(3) The frequency of oscillation of kinetic energy is $2f$
(4) Velocity function leads acceleration in phase by $\pi/2$
- Which of the following is correct about a SHM, along a straight line ?
(1) Ratio of acceleration to velocity is constant.
(2) Ratio of acceleration to potential energy is constant.
(3) Ratio of acceleration to displacement from the mean position is constant.
(4) Ratio of acceleration to kinetic energy is constant.
- Two identical springs of constant k are connected in series and parallel as shown in figure. A mass ' m ' is suspended from them. The ratio of their frequencies of vertical oscillations will be :-



- (1) $2 : 1$ (2) $1 : 1$ (3) $1 : 2$ (4) $4 : 1$
- A force of 6.4 N stretches a vertical spring by 0.1 m . The mass that must be suspended from the spring so that it oscillates with a time period of $\pi/4$ second :-
(1) $\frac{\pi}{4}\text{ kg}$ (2) $\frac{4}{\pi}\text{ kg}$
(3) 1 kg (4) 10 kg

12. A system is shown in the figure. The time period for small oscillations of the two blocks will be :-



- (1) $2\pi\sqrt{\frac{3m}{k}}$ (2) $2\pi\sqrt{\frac{3m}{2k}}$
(3) $2\pi\sqrt{\frac{3m}{4k}}$ (4) $2\pi\sqrt{\frac{3m}{8k}}$

13. A mass M is suspended with a light spring. An additional mass m added displaces the spring further by a distance x . Now, the combined mass will oscillate on the spring with period :

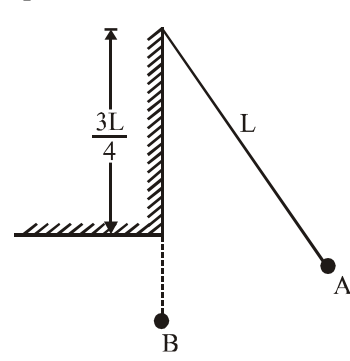
- (1) $T = 2\pi\sqrt{\frac{mg}{x(M+m)}}$
(2) $T = 2\pi\sqrt{\frac{(M+m)x}{mg}}$
(3) $T = \frac{\pi}{2}\sqrt{\frac{m}{x(M+m)}}$
(4) $T = 2\pi\sqrt{\frac{M+m}{mgx}}$

ANSWERS

1. 4	2. 4	3. 1	4. [A-q, B-r, C-s]	5. 2,3	6. 3	7. 4	8. 2,3
9. 3	10. 3	11. 3	12. 3	13. 2			

Oscillations (Simple pendulum and types of SHM)

RACE # 03

- Two pendulums of length 1.21 m and 1.0 m starts vibrating. At some instant, the two are in the mean position in same phase. After how many vibrations of the longer pendulum, the two will be in phase ?
 (1) 10 (2) 11
 (3) 20 (4) 21
- The time period of oscillations of a simple pendulum is 1 minute. If its length is increased by 44%, then its new time period of oscillations will be :-
 (1) 96s (2) 58s
 (3) 82s (4) 72s
- A 100 g mass stretches a particular spring by 9.8 cm, when suspended vertically from it. How large a mass must be attached to the spring if the period of vibration is to be 6.28 s?
 (1) 1000g (2) 10^5 g
 (3) 10^7 g (4) 10^4 g
- In forced oscillations, a particle oscillates simple harmonically with a frequency equal to:-
 (1) Frequency of driving force
 (2) Natural frequency of body
 (3) Difference of frequency of driving force and natural frequency
 (4) Mean of frequency of driving force and natural frequency
- A simple pendulum of length 40 cm oscillates with an angular amplitude of 0.04 rad. Find
 (a) The time period
 (b) The linear amplitude of the bob
 (c) The speed of the bob when the string makes 0.02 rad with the vertical
 (d) The angular acceleration when the bob is in momentary rest (take $g = 10 \text{ m/s}^2$)
- The time period and the amplitude of a simple pendulum are 4 seconds and 0.20 meter respectively. If the displacement is 0.1 meter at time $t = 0$, the equation of its displacement is represented by :-
 (1) $y = 0.2 \sin (0.5\pi t)$
 (2) $y = 0.1 \sin (0.5\pi t + \frac{\pi}{6})$
 (3) $y = 0.1 \sin \left(\pi t + \frac{\pi}{6} \right)$
 (4) $y = 0.2 \sin \left(0.5\pi t + \frac{\pi}{6} \right)$
- A simple pendulum of length 1m is attached to the ceiling of an elevator which is accelerating upward at the rate of 1m/s^2 . Its frequency is approximately :-
 (1) 2 Hz
 (2) 1.5 Hz
 (3) 5 Hz
 (4) 0.5 Hz
- A pendulum has period T for small oscillations. An obstacle is placed directly beneath the pivot, so that only the lowest one quarter of the string can follow the pendulum bob when it swings in the left of its resting position as shown in the figure. The pendulum is released from rest at a certain point A. The time taken by it to return to that point is :-

 (1) T (2) T/2 (3) 3T/4 (4) T/4

9. The bob of a simple pendulum is a spherical hollow ball filled with water. A plugged hole near the bottom of the oscillating bob gets suddenly unplugged. During observation, the time period of oscillation would :-
 (1) remain unchanged
 (2) increase towards a saturation value
 (3) first increase and then decrease to the original value
 (4) first decrease and then increase to the original value
10. Choose the correct statement :-
 (1) Time period of a simple pendulum depends on amplitude.
 (2) Time shown by a spring watch varies with acceleration due to gravity g .
 (3) In a simple pendulum, time period varies linearly with the length of the pendulum.
 (4) The graph between length of the pendulum and time period is a parabola.
11. A simple pendulum has a time period T in vacuum. Its time period when it is completely immersed in a liquid of density $\frac{1}{8}$ th of material of the bob is :-
 (1) $\sqrt{\frac{7}{8}}T$ (2) $\sqrt{\frac{5}{8}}T$
 (3) $\sqrt{\frac{3}{8}}T$ (4) $\sqrt{\frac{8}{7}}T$
12. The time period of a simple pendulum in a stationary train is T . The time period of a mass attached to a spring is also T . The train accelerates at the rate 5 m/s^2 . If the new time periods of the pendulum and spring be T_p and T_s respectively, then :-
 (1) $T_p = T_s$ (2) $T_p > T_s$
 (3) $T_p < T_s$ (4) Cannot be predicted

ANSWERS

1. 1	2. 4	3. 4	4. 1	5. [1.26 s, 1.6 cm, 6.8 cm/s, 1 rad/s²]		
6. 4	7. 4	8. 3	9. 3	10. 4	11. 4	12. 3

Wave Motion & Doppler's Effect (Fundamental)

RACE # 01

1. Let speed of sound waves in hydrogen gas at room temperature is v_0 . What will be the speed of sound waves in a room which contains an equimolar mixture of hydrogen and 'He' at same temperature :-

- (1) $\sqrt{\frac{5}{7}} v_0$ (2) $\sqrt{\frac{7}{5}} v_0$
(3) $\sqrt{\frac{2}{5}} v_0$ (4) None

2. Two particles of medium disturbed by the wave propagation are at $x_1 = 0$ and $x_2 = 1\text{cm}$. The respective displacements (in cm) of the particles can be given by the equations :-

$$y_1 = 2\sin 3\pi t$$

$$y_2 = 2\sin(3\pi t - \pi/8)$$

The wave velocity is :

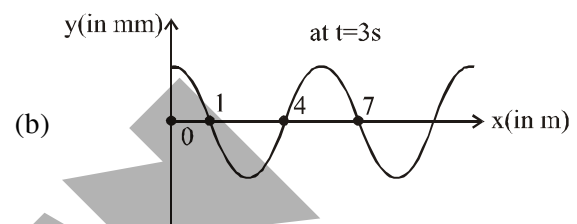
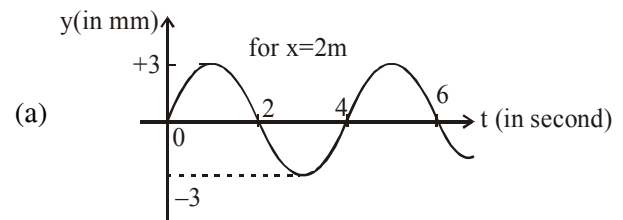
- (1) 16 cm/sec
(2) 24 cm/sec
(3) 12 cm/sec
(4) 8 cm/sec
3. Two small boats are 10m apart on a lake. Each pops up and down with a period of 4.0 seconds due to wave motion on the surface of water. When one boat is at its highest point, the other boat is at its lowest point. Both boats are always within a single cycle of the waves. The speed of the waves is :-

- (1) 2.5 m/s
(2) 5.0 m/s
(3) 14 m/s
(4) 40 m/s

4. The displacement wave in a string is $y = (3\text{ cm}) \sin 6.28 (0.5x - 50t)$ where x is in centimetres and t in seconds. The velocity and wavelength of the wave is :-

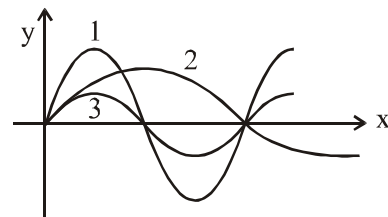
- (1) 100 cms^{-1} , 2 cm
(2) 50 cms^{-1} , 10 cm
(3) 2 ms^{-1} , 20 cm
(4) 100 ms^{-1} , 2 m

5. A sinusoidal wave propagates along a string. In figure (a) and (b) 'y' represents displacement of particle from the mean position. 'x' & 't' have usual meanings. Find :-



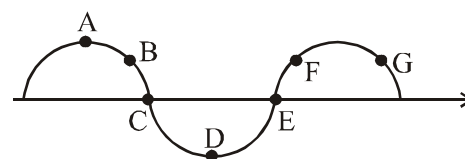
- (a) wavelength, frequency and speed of the wave
(b) maximum velocity and maximum acceleration of the particles

6. Graph shows three waves that are separately sent along a string that is stretched under a certain tension along x-axis. If ω_1, ω_2 and ω_3 are their angular frequencies respectively then :-



- (1) $\omega_1 = \omega_3 > \omega_2$ (2) $\omega_1 > \omega_2 > \omega_3$
(3) $\omega_1 > \omega_2 = \omega_3$ (4) $\omega_1 = \omega_2 = \omega_3$

7. The following figure depicts a wave travelling in a medium. Which pair of particles are in phase :-

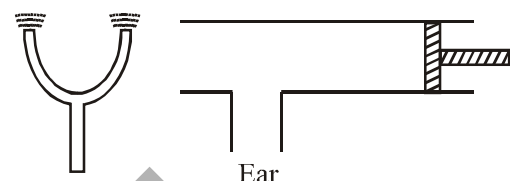


- (1) A and D (2) B and F
(3) C and E (4) B and G

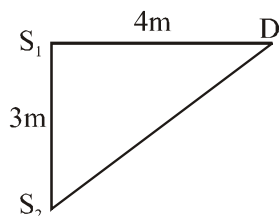
8. A transverse periodic wave on a string with a linear mass density of 0.200 kg/m is described by the following equation $y = 0.05 \sin (420t - 21.0x)$ where x and y are in metres and t is in seconds. The tension in the string is equal to :
(1) 32 N (2) 42 N (3) 66 N (4) 80 N
9. Under similar conditions of temperature and pressure, In which of the following gases the velocity of sound will be largest :-
(1) H_2 (2) N_2 (3) He (4) CO_2
10. The velocity of sound in a gas at temperature 27°C is V then in the same gas its velocity will be $2V$ at temperature :-
(1) 54°C (2) 327°C (3) 927°C (4) 108°C
11. The frequency of a tuning fork is 384 Hz and velocity of sound in air is 352 ms^{-1} . How far sound has travelled when fork completes 36 vibration :-
(1) 33m (2) 16.5 m (3) 11 m (4) 22 m
12. Ultrasonic, infrasonic and audio waves travel through a medium with speeds V_u , V_i and V_a respectively then :-
(1) V_u , V_i and V_a are equal
(2) $V_u > V_a > V_i$
(3) $V_u < V_a < V_i$
(4) $V_a < V_u$ and $V_u \approx V_i$
13. Consider the wave represented by,
 $y = \cos (500 t - 70 x)$ where y is in mm, x in m and t in seconds. Which of the following is/are true ?
(1) the wave is a standing wave
(2) the speed of the wave is $50/7 \text{ ms}^{-1}$
(3) the frequency of oscillation is $500 \times 2\pi \text{ Hz}$
(4) two nearest points in the same phase have separation $20\pi / 7 \text{ cm}$
14. The frequency of man's voice is 300 Hz and its wavelength is 1 meter. If the wavelength of a child's voice is 1.5m, then the frequency of the child's voice in same medium is :-
(1) 200 Hz (2) 150 Hz
(3) 400 Hz (4) 450 Hz
15. Which of the following expressions is that of a simple harmonic progressive wave ?
(1) $A \sin \omega t$ (2) $A \sin \omega t \cos kx$
(3) $A \sin (\omega t - kx)$ (4) $A \cos kx$
16. If the density of air at NTP is 1.293 kg/m^3 and $\gamma = 1.41$, then the velocity of sound in air at NTP is :
(1) 102.3 m/s (2) 252.3 m/s
(3) 332.3m/s (4) 432.3 m/s
17. Light can travel in vacuum but not sound, because
(1) speed of sound is very much slower than light
(2) light waves are electromagnetic in nature
(3) sound waves are electromagnetic in nature
(4) light waves are not electromagnetic in nature

ANSWER KEY

1. 1	2. 2	3. 2	4. 1	5. (a) 6m, 0.25 Hz, 1.5 m/s , (b) 1.5π mm/s, $0.75\pi^2$ mm/s							
6. 1	7. 4	8. 4	9. 1	10. 3	11. 1	12. 1	13. 2,4	14. 1	15. 3	16. 3	17. 2

- Three tuning forks of frequencies 200, 201 and 204 Hz are sounded together. The beat frequency will be :-
 (1) 6 (2) 12
 (3) 15 (4) None of these
- Three waves producing displacement in the same direction of same frequency and of amplitudes $10\mu\text{m}$, $4\mu\text{m}$ and $7\mu\text{m}$ arrive at a point with successive phase difference of $\pi/2$. The amplitude of the resultant wave is :-
 (1) $2\mu\text{m}$ (2) $7\mu\text{m}$
 (3) $5\mu\text{m}$ (4) 1
- Two coherent sources of different intensities send waves which interfere. The ratio of the maximum intensity to the minimum intensity is 25. The intensities are in the ratio :-
 (1) 25 : 1 (2) 5 : 1
 (3) 9 : 4 (4) 625 : 1
- If two tuning forks A and B are sounded together, they produce 4 beats per second. A is then slightly loaded with wax, they produce same beats when sounded again. The frequency of A is 256 Hz. The frequency of B will be :-
 (1) 250 Hz (2) 252 Hz
 (3) 260 Hz (4) 262 Hz
- When two progressive waves of intensity I_1 and I_2 but slightly different frequencies superpose, the resultant intensity fluctuates between :-
 (1) $(\sqrt{I_1} + \sqrt{I_2})^2$ and $(\sqrt{I_1} - \sqrt{I_2})^2$
 (2) $(\sqrt{I_1} + \sqrt{I_2})$ and $(\sqrt{I_1} - \sqrt{I_2})$
 (3) $(I_1 + I_2)$ and $(\sqrt{I_1} - \sqrt{I_2})$
 (4) $\frac{I_1}{I_2}$ and $\frac{I_2}{I_1}$
- A vibrating tuning fork of frequency n is placed near the open end of a long cylindrical tube. The tube has a side opening and is also fitted with a movable reflecting piston. As the piston is moved through 8.75 cm, the intensity of sound changes from a maximum to minimum. If the speed of sound is 350 metre per second, then n is :-

 (1) 500 Hz (2) 1000 Hz
 (3) 2000 Hz (4) 4000 Hz
- The path difference between the two waves
 $y_1 = a_1 \sin(\omega t - kx)$
 and $y_2 = a_2 \cos(\omega t - kx + \phi)$,
 is
 (1) $(\lambda/2\pi)\phi$
 (2) $\left(\frac{\phi + (\pi/2)}{2\pi}\right)\lambda$
 (3) $\frac{2\pi}{\lambda}\left(\phi - \frac{\pi}{2}\right)$
 (4) $\frac{2\pi}{\lambda}\phi$
- Two tuning forks of frequencies n_1 and n_2 produce n beats per second. If n_2 and n are known, n_1 may be given by :-
 (1) $\frac{n_2}{n} + n_2$
 (2) $n_2 n$
 (3) $n_2 \pm n$
 (4) $\frac{n_2}{n} - n_2$

9. In the figure the intensity of waves arriving at D from two coherent sources S_1 and S_2 is I_0 . The wavelength of the wave is $\lambda = 4\text{m}$. Resultant intensity at D will be :-



- (1) $4I_0$ (2) I_0 (3) $2I_0$ (4) zero

10. When a guitar is sounded with a 440 Hz tuning fork, a beat frequency of 5 Hz is heard. If the experiment is repeated with a tuning fork of 437 Hz, the beat frequency is 8 Hz. The string frequency (in Hz) is :-

- (1) 445 (2) 435 (3) 429 (4) 448

11. If two waves of same frequency and same amplitude respectively, on superposition, produce a resultant disturbance of the same amplitude, the waves differ in phase by :-

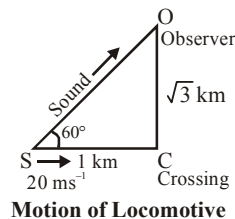
- (1) π (2) $2\pi/3$ (3) $\pi/3$ (4) 3π

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	
Ans	1	3	3	2	1	2	2	3	3	1	2	

1. A locomotive approaching a crossing at a speed of 20 ms^{-1} sounds a whistle of frequency 640 Hz when 1 km from the crossing. There is no wind and the speed of sound in air is 330 ms^{-1} . What frequency is heard by an observer $\sqrt{3} \text{ km}$ on the straight road from the crossing at right angle :-

- (1) 600 Hz
(2) 630 Hz
(3) 660 Hz
(4) 720 Hz



2. An aluminium rod having a length 100 cm is clamped at its middle point and set into longitudinal vibrations. Let the rod vibrate in its fundamental mode. The density of aluminium is 2600 kg/m^3 and its Young's modulus is $7.8 \times 10^{10} \text{ N/m}^2$. The frequency of the sound produced is :-

- (1) 1250 Hz (2) 2740 Hz
(3) 2350 Hz (4) 1685 Hz

3. If in a stationary wave the amplitude corresponding to antinode is 4 cm , then the amplitude corresponding to a particle of medium located exactly midway between a node and an antinode is :-

- (1) 2 cm (2) $2\sqrt{2} \text{ cm}$ (3) $\sqrt{2} \text{ cm}$ (4) 1.5 cm

4. What is the phase difference between the displacement wave and pressure wave in sound wave :-

- (1) Zero (2) $\frac{\pi}{2}$
(3) π (4) $\frac{\pi}{4}$

5. A wire of length ' ℓ ' having tension T and radius ' r ' vibrates with fundamental frequency ' f '. Another wire of the same metal with length 2ℓ having tension $2T$ and radius $2r$ will vibrate with fundamental frequency :-

- (1) f (2) $2f$
(3) $\frac{f}{2\sqrt{2}}$ (4) $\frac{f}{2}\sqrt{2}$

6. Equation of a standing wave is generally expressed as $y = 2A \sin \omega t \cos kx$. In the equation, quantity ω/k represents :-

- (1) the transverse speed of the particles of the string
(2) the speed of either of the component wave
(3) the speed of the standing wave
(4) a quantity that is independent of the properties of the string.

7. Two vibrating strings of same material stretched under same tension and vibrating with same frequency in the same overtone have radii $2r$ and r . Then the ratio of their lengths is :-

- (1) $1 : 2$ (2) $1 : 4$
(3) $1 : 3$ (4) $2 : 3$

8. The wave function for a certain standing wave on a string fixed at both ends is $y(x,t) = 0.5 \sin(0.025\pi x) \cos 500 t$ where x and y are in centimeters and t is in seconds. The shortest possible length of the string is :-

- (1) 126 cm (2) 160 cm
(3) 40 cm (4) 80 cm

9. A string vibrates in 5 segments to a frequency of 480 Hz . The frequency that will cause it vibrate in 2 segments will be :-

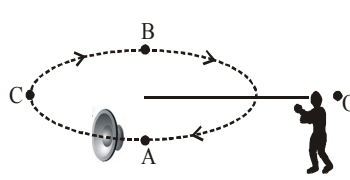
- (1) 96 Hz (2) 192 Hz
(3) 1200 Hz (4) 2400 Hz

10. A 2.0 m long string with a linear mass density of $5.2 \times 10^{-3} \text{ kg m}^{-1}$ and tension 52 N has both of its ends fixed. It vibrates in a standing wave pattern with four antinodes. Frequency of the vibration is :-

- (1) 75 Hz (2) 150 Hz (3) 100 Hz (4) 50 Hz

11. A wave is represented by the equation $y = 10 \sin 2\pi(100 t - 0.02x) + 10 \sin 2\pi(100 t + 0.02x)$. The maximum amplitude and loop length are respectively :-

- (1) 20 units and 30 units
(2) 20 units and 25 units
(3) 30 units and 20 units
(4) 25 units and 20 units

12. In case of closed organ pipe which harmonic the p^{th} overtone will be :-
 (1) $2p + 1$ (2) $2p - 1$ (3) $p + 1$ (4) $p - 1$
13. An organ pipe of length L is open at one end and closed at other end. The wavelengths of the three lowest resonating frequencies that can be produced by this pipe are :-
 (1) $4L, 2L, L$ (2) $2L, L, L/2$
 (3) $2L, L, 2L/3$ (4) $4L, 4L/3, 4L/5$
14. A man sitting in a moving train hears the whistle of the engine. The frequency of the whistle is 600 Hz :-
 (1) The apparent frequency as heard by him is smaller than 600 Hz
 (2) The apparent frequency is larger than 600 Hz
 (3) The frequency as heard by him is 600 Hz
 (4) None of the above
15. A whistle of frequency 500 Hz tied to the end of a string of length 1.2 m revolves at 400 rev/min. A listener standing some distance away in the plane of rotation of whistle hears frequencies in the range (speed of sound = 340 m/s) :-
 (1) 436 to 586 (2) 426 to 574
 (3) 426 to 584 (4) 436 to 674
16. If source and observer both are relatively at rest and if speed of sound is increased then frequency heard by observer will :-
 (1) Increases (2) Decreases
 (3) Can not be predicted (4) Will not change
17. A small source of sound moves on a circle as shown in the figure and an observer is standing at O. Let n_1, n_2 and n_3 be the frequencies heard when the source is at A, B and C respectively. Then :-
- 
- (1) $n_1 > n_2 > n_3$ (2) $n_2 > n_3 > n_1$
 (3) $n_1 = n_2 > n_3$ (4) $n_2 > n_1 > n_3$
18. An observer moves towards a stationary source of sound, with a velocity one-fifth of the velocity of sound. What is the percentage increase in the apparent frequency compared to actual frequency :-
 (1) 5% (2) 20%
 (3) zero (4) 0.5%
19. The length of a sonometer wire is 1.25m and density $8 \times 10^3 \text{ kg/m}^3$. It can bear a stress of $3.2 \times 10^8 \text{ N/m}^2$ without exceeding the elastic limit. The fundamental frequency that can be produced in the wire, is :-
 (1) 100 Hz (2) 80 Hz
 (3) 200 Hz (4) 250 Hz

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	3	2	2	2	3	2	1	3	2	3	2	1	4	3	1
Que.	16	17	18	19											
Ans	4	2	2	2											

ELECTRIC CHARGE & COULOMB'S LAW

RACE # 01

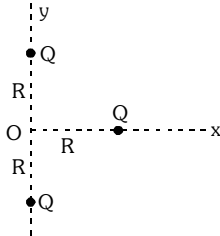
1. Find net force on charge Q placed on X-axis.

(1) $\frac{\sqrt{2}Q^2}{8\pi\epsilon_0 R^2}$

(2) $\frac{\sqrt{2}Q^2}{4\pi\epsilon_0 R^2}$

(3) $\frac{\sqrt{2}Q^2}{8\pi\epsilon_0 R}$

(4) $\frac{2\sqrt{2}Q^2}{8\pi\epsilon_0 R^2}$



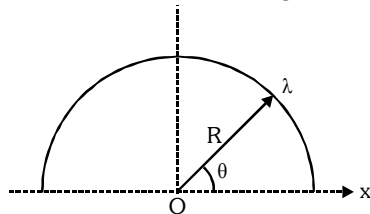
2. Linear charge density of a half ring varies with θ as $\lambda = \lambda_0 \cos\theta$. then find total charge of ring.

(1) $\lambda_0 R$

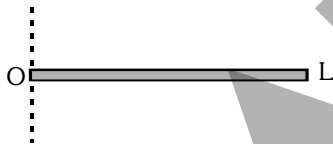
(2) Zero

(3) $\sqrt{2} \lambda_0 R$

(4) $2\lambda_0 R$



3. If linear charge density of a wire of length L depends on distance x from one end as $\lambda = \frac{\lambda_0 x}{L}$. Find total charge of wire.



(1) $\lambda_0 L$ (2) $\frac{\lambda_0 L}{2}$ (3) $\frac{\lambda_0 L}{4}$ (4) $2\lambda_0 L$

4. Coulomb's law is analogous to :-

(1) Charge conservation law

(2) Newton's second law of motion

(3) Law of conservation of energy

(4) Newton's law of gravitation

5. Two equal point charges A and B are R distance apart. A third point charge placed on the perpendicular bisector at a distance 'x' from the centre will experience maximum electrostatic force when :-

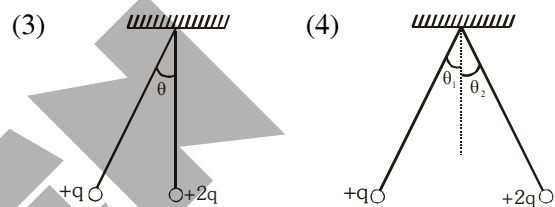
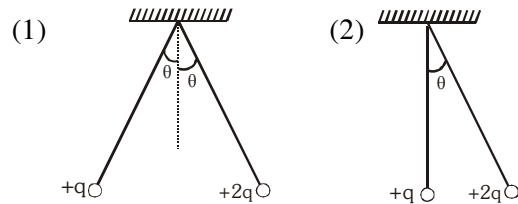
(1) $x = \frac{R}{2\sqrt{2}}$

(2) $x = \frac{R}{\sqrt{2}}$

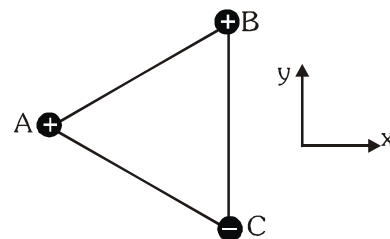
(3) $x = R\sqrt{2}$

(4) $x = 2\sqrt{2}R$

6. Two metal spheres of same mass are suspended from a common point by a light insulating string. The length of each string is same. The spheres are given electric charges +q on one and +2q on the other. Which of the following diagram best shows the resulting positions of spheres?



7. Three point charges lie at the vertices of an equilateral triangle as shown. All three charges have the same magnitude, but charge A and B are positive and charge C is negative. The net electric force that charges B and C exert on A



- (1) is in the +x direction
(2) is in the -x direction
(3) is in the +y direction
(4) is in the -y direction

8. Mark correct option :-

- (1) The total charge of universe is constant
(2) The total positive charge of universe is constant
(3) The total negative charge of universe is constant
(4) The total number of charge particles in universe is constant

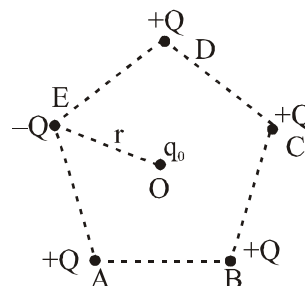
9. A proton and an electron are placed in uniform electric field :-

- (1) The electric forces acting on them will be equal
- (2) The magnitudes of the electric force will be equal
- (3) Their accelerations will be equal
- (4) The magnitudes of their accelerations will be equal

10. Dielectric constant of pure water is 81. It's permittivity will be (In SI unit) :-

- (1) 7.17×10^{-10}
- (2) 8.86×10^{-12}
- (3) 1.02×10^{-13}
- (4) None

11. Five charges of equal values placed at corners of a regular pentagon of side 'a'. The force on q_0 which is placed at centroid 'O' is :-



- (1) zero
- (2) $\frac{2kQq_0}{r^2}$, along OE
- (3) $\frac{2kQq_0}{r^2}$, along EO
- (4) $\frac{kQq_0}{r^2}$, along OE

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11
Ans	1	2	2	4	1	1	4	1	2	1	2

ELECTRIC FIELD INTENSITY, FIELD LINES

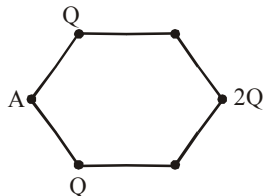
RACE # 02

1. A rod of length L has a total charge Q distributed uniformly along its length. It is bent in the shape of a semicircle. Find the magnitude of the electric field at the centre of curvature of the semicircle.

(1) $Q/2\epsilon_0 L^2$ (2) $Q/\epsilon_0 L^2$

(3) $\frac{2Q}{\epsilon_0 L^2}$ (4) Zero

2. Regular hexagon with side length 'a' is shown in fig. Find E_A ?



(1) $\frac{2kQ}{a^2}$ (2) $\frac{3}{2} \frac{kQ}{a^2}$ (3) $\frac{5}{4} \frac{kQ}{a^2}$ (4) $\frac{kQ}{a^2}$

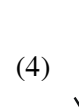
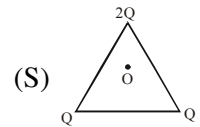
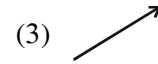
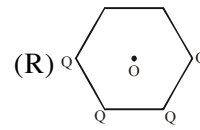
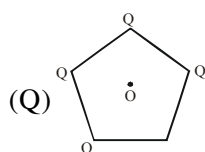
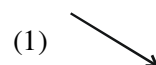
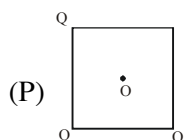
3. As one moves towards the centre from surface of a uniformly charged metallic sphere, the electric field strength E ,

- (1) increases
(2) decreases
(3) remains same as that of the surface
(4) is zero at all points

4. In the given diagrams the direction of electric field at point O is given in list-II (O is circumcenter of the given regular polygon). Charge Q is positive. Match the direction of electric field for the given arrangement:-

List-I

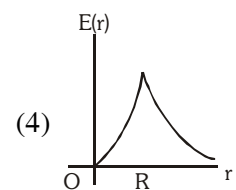
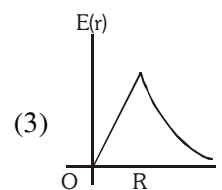
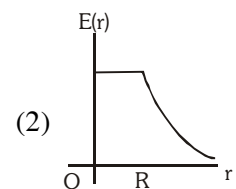
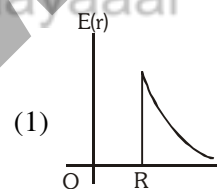
List-II



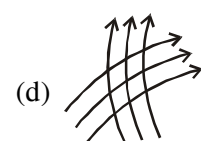
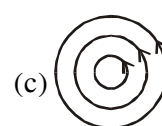
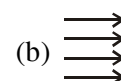
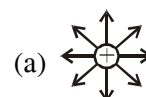
Code :-

P	Q	R	S
(1) 2	1	4	3
(2) 3	1	2	4
(3) 3	2	1	4
(4) 1	4	3	2

5. A uniform sphere of radius R has a charge Q spread uniformly over its volume. Which of the following graphs most closely represents the electric field $E(r)$ produced in the range $0 \leq r < \infty$, where r is the distance from the centre of the sphere ?

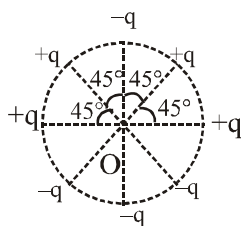


6. The figures shows electrostatic lines of force, which pattern is incorrect :-

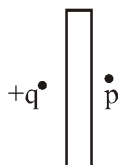


- (1) a,c (2) b,c (3) only d (4) c,d

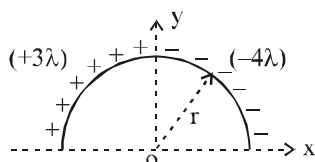
7. Eight charge particles are placed at circumference of circle of radius r . The net electric field at the centre of circle is :-



- (1) zero (2) $\frac{q}{\sqrt{2}\pi\epsilon_0 r^2}$
 (3) $\frac{\sqrt{2}q}{\pi\epsilon_0 r^2}$ (4) $\frac{2q}{\pi\epsilon_0 r^2}$
8. An electric field can deflect :-
 (1) x-rays (2) neutron
 (3) α -particle (4) γ -rays
9. A point charge $+q$ is placed in front of a neutral metal plate. The direction of electric field at point 'P' on the other side of the plate is :-

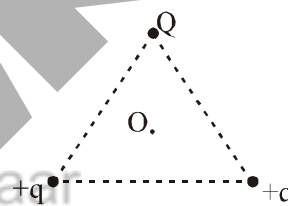


- (1) perpendicular to the plate & away from plane of plate
 (2) Perpendicular to the plate & towards plane of plate
 (3) Radially away from $+q$
 (4) Radially towards from $+q$
10. A semicircular arc placed in xy plane is charged as shown in figure. The electric field at centre 'O' is :-

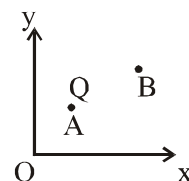


- (1) $\frac{5\sqrt{2}\lambda}{4\pi\epsilon_0 r}$, above $+x$ direction
 (2) $\frac{5\sqrt{2}\lambda}{4\pi\epsilon_0 r}$, below $+x$ direction
 (3) $\frac{5\sqrt{2}\lambda}{4\pi\epsilon_0 r}$, along $+x$ direction
 (4) $\frac{25\lambda}{4\pi\epsilon_0 r}$, along $+x$ direction

11. Three charges are placed at corners of an equilateral triangle as shown in figure. The magnitude of electric field at centre 'O' due to q is E and total field at centre O is $3E$ then :-



- (1) $Q = +4q$ (2) $Q = -2q$
 (3) $Q = -3q$ (4) Both (1) & (2) are possible
12. A point charge when placed at point A(3,4) m in xy plane then electric field at origin is E . If charge is moved from A to B (24, 7) m then electric field at origin is :-



- (1) $E/25$ (2) $25E$
 (3) $5E$ (4) $E/5$

ANSWER KEY

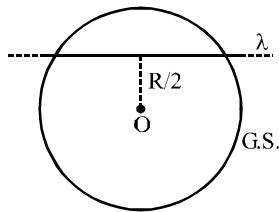
Que.	1	2	3	4	5	6	7	8	9	10	11	12
Ans	1	2	4	2	3	4	2	3	1	1	4	1

ELECTRIC FIELD GAUSS THEOREM & IT'S APPLICATION

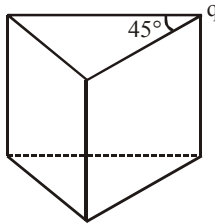
RACE # 03

1. Find flux from G.S. (Radius of sphere is R)

(1) $\frac{\sqrt{3}\lambda R}{2\epsilon_0}$ (2) $\frac{\sqrt{3}\lambda R}{\epsilon_0}$
(3) $\frac{\lambda R}{\epsilon_0}$ (4) $\frac{2\lambda R}{\epsilon_0}$

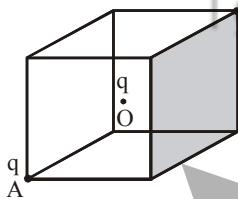


2. A prism shaped imaginary structure is given. A point charge is kept as given in figure. Calculate electric flux passing through the prism.



(1) $\frac{q}{4\epsilon_0}$ (2) $\frac{q}{8\epsilon_0}$ (3) $\frac{q}{16\epsilon_0}$ (4) $\frac{q}{32\epsilon_0}$

3. Two point charge, each of q, are kept at centre of cube O and vertex A. Find ϕ_e from shaded face.

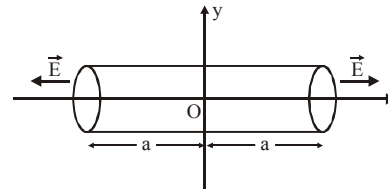


(1) $\frac{5q}{8\epsilon_0}$ (2) $\frac{7q}{24\epsilon_0}$ (3) $\frac{2q}{\epsilon_0}$ (4) $\frac{5q}{24\epsilon_0}$

4. A long wire of linear charge density λ passes through a cube of side 'l' in such a manner that flux through it is maximum. Now the position of the wire is changed in such a manner that (wire is parallel to any side) flux is minimum. The ratio of maximum flux to minimum flux is :-

(1) $\sqrt{3}:1$ (2) $3:1$ (3) $\sqrt{2}:1$ (4) $\sqrt{3}:\sqrt{2}$

5. A right circular cylinder of length 2a cm and radius r cm has its centre at the origin O and its axis along the x-axis so that one flat face is at $x = +a$ cm and the other is at $x = -a$ cm as is shown in the figure. It is placed in a uniform electric field $\vec{E} = E_x \hat{i}$ NC⁻¹ for $x > 0$ and $\vec{E} = -E_x \hat{i}$ NC⁻¹ for $x < 0$. Then



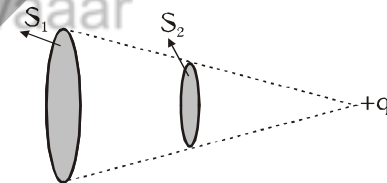
- (1) The net outward flux through each flat surface is $E_a \pi r^2 \times 10^{-6}$ Nm²/C
(2) The net outward flux through curved surface of the cylinder is zero
(3) The net charge inside the cylinder is

$E_a r^2 \times 5.5 \times 10^{-15}$ C

- (4) The net charge inside the cylinder is

$E_a r^2 \times 25 \times 10^{-15}$ C

6. Two surfaces S_1 & S_2 are shown in figure. Flux associated with S_1 is ϕ_1 & S_2 is ϕ_2 . Which is correct?

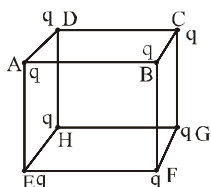


- (1) $\phi_1 > \phi_2$
(2) $\phi_1 < \phi_2$
(3) $\phi_1 = \phi_2$
(4) can't say anything

7. Which of the following is sufficient condition for finding the electric flux Φ_E through a closed surface?

- (1) If the magnitude of $\vec{E}$ is known everywhere on the surface
(2) If the total charge inside the surface is specified
(3) If the total charge outside the surface is specified
(4) Only if the location of each point charge inside the surface is specified

8. Eight point charges having magnitude q are fixed at vertices of a cube. The electric flux through square surface ABCD of the cube is



(1) $\frac{q}{24 \epsilon_0}$

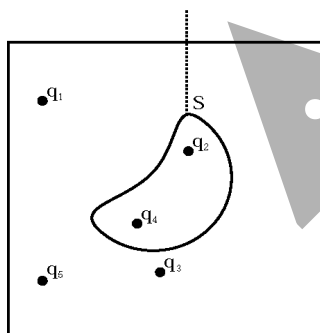
(2) $\frac{q}{12 \epsilon_0}$

(3) $\frac{q}{6 \epsilon_0}$

(4) $\frac{q}{3 \epsilon_0}$

9. Five charges $q_1, q_2, q_3, q_4,$ and q_5 are fixed at their positions as shown in Fig. S is a Gaussian surface. The Gauss's law is given by $\oint E \cdot ds = \frac{q}{\epsilon_0}$. Which of the following statements is correct?

Gaussian Surface

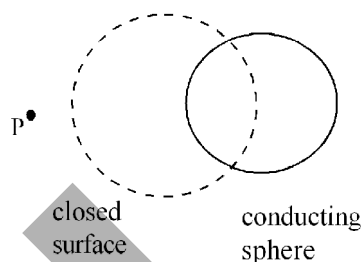


- (1) E on the LHS of the above equation will have a contribution from q_1, q_5 and q_3 while q on the RHS will have a contribution from q_2 and q_4 only.
- (2) E on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_2 and q_4 only.

- (3) E on the LHS of the above equation will have a contribution from all charges while q on the RHS will have a contribution from q_1, q_3 and q_5 only.

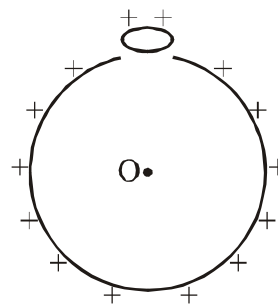
- (4) Both E on the LHS and q on the RHS will have contributions from q_2 and q_4 only.

10. Figure shows a closed surface which intersects a conducting sphere. If a positive charge is placed at the point P, the net flux of the electric field through the closed surface



- (1) will remain zero
- (2) will become positive
- (3) will become negative
- (4) will become undefined

11. A conducting charged spherical shell has a tiny hole cut into its surface. If surface charge density near the hole is σ then electric field in the hole is :-



- (1) $\frac{\sigma}{\epsilon_0}$, directed inwards
- (2) $\frac{\sigma}{\epsilon_0}$, directed outwards
- (3) $\frac{\sigma}{2 \epsilon_0}$, directed inwards
- (4) $\frac{\sigma}{2 \epsilon_0}$, directed outwards

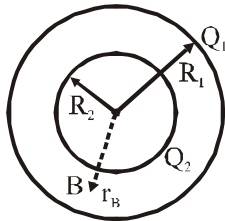
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11
Ans	2	3	4	1	2,3	3	2	3	2	3	4

ELECTRIC POTENTIAL ENERGY & ELECTRIC POTENTIAL

RACE # 04

1. You are given two concentric charged conducting spheres of radii R_1 and R_2 such that $R_1 > R_2$, having charges Q_1 and Q_2 respectively and uniformly distributed over its surface. Calculate E and V at point B whose distance from the centre is r_B as shown in figure :-



(1) $E = \frac{Q_1}{4\pi\epsilon_0 r_B^2}$, $V = \frac{Q_1}{4\pi\epsilon_0 R_1}$

(2) $E = \frac{Q_2}{4\pi\epsilon_0 r_B^2}$, $V = \frac{Q_1}{4\pi\epsilon_0 R_1} + \frac{Q_2}{4\pi\epsilon_0 r_B}$

(3) $E = \frac{(Q_1 + Q_2)}{4\pi\epsilon_0 r_B^2}$, $V = \frac{Q_1}{4\pi\epsilon_0 R_1} + \frac{Q_2}{4\pi\epsilon_0 r_B}$

(4) $E = 0$, $V = 0$

2. Eight equal charges q are placed at each corner of a cube of side a each. Work done in carrying a charge $-q$ from its centre to infinity is

(1) zero

(2) $\frac{3\sqrt{2}q^2}{\pi\epsilon_0 a}$

(3) $\frac{\sqrt{2}q^2}{\pi\epsilon_0 a}$

(4) $\frac{4q^2}{\sqrt{3}\pi\epsilon_0 a}$

3. The electric field intensity at a point at a distance 2 m from a charge q is 4N/C. Find the amount of work done (in joule) in bringing a charge of 1 coulomb from infinity to this point.

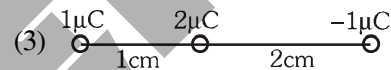
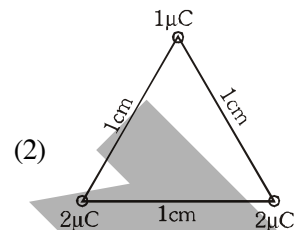
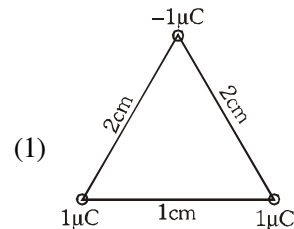
(1) 2 J

(2) 4 J

(3) 8 J

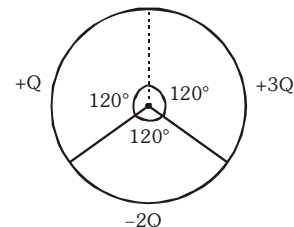
(4) 16 J

4. Which of the following systems of charges have zero electrostatic potential energy?



(4) None of these

5. Figure shows three circular arcs, each of radius R and total charge as indicated. The net electric potential at the centre of curvature is



(1) $\frac{Q}{4\pi\epsilon_0 R}$

(2) $\frac{Q}{2\pi\epsilon_0 R}$

(3) $\frac{2Q}{\pi\epsilon_0 R}$

(4) $\frac{Q}{\pi\epsilon_0 R}$

6. A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10 V. The potential at the centre of the sphere is

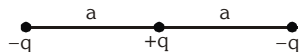
(1) 0 V

(2) 10 V

(3) same as at point 5 cm away from the surface out side sphere.

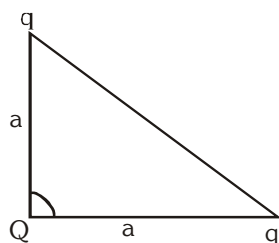
(4) same as a point 25 cm away from the surface.

7. Three point charges shown in the figure below along a straight line. The work done against electrostatic forces to exchange the position of the central +ve charge with one of the negative charge is



- (1) $\frac{q^2}{4\pi\epsilon_0 a}$ (2) $\frac{q^2}{8\pi\epsilon_0 a}$ (3) $\frac{-q^2}{8\pi\epsilon_0 a}$ (4) $\frac{-q^2}{4\pi\epsilon_0 a}$

8. Three charges Q , q & q are placed at the vertices of a right angle isosceles triangle as shown. The net electrostatic energy of the configuration is zero, if q/Q is equal to



- (1) -1 (2) $-\sqrt{2}$
(3) -2 (4) $-2\sqrt{2}$

9. Three point charge q , $-2q$ and $-2q$ are placed at the vertices of an equilateral triangle of side a . The minimum work done by some external force to increase their separation to $2a$ will be

- (1) $\frac{1}{4\pi\epsilon_0} \frac{2q^2}{a}$ (2) negative
(3) zero (4) $\frac{1}{4\pi\epsilon_0} \frac{3q^2}{a}$

10. A solid sphere of radius R is charged uniformly. At what distance from its surface is the electrostatic potential half of the potential at the centre?
- (1) R (2) $R/2$ (3) $R/3$ (4) $2R$

11. Two concentric conducting spheres of radii R and $2R$ carrying charges Q and $-3Q$ respectively. If the charge on inner sphere is doubled, the potential difference between two spheres will

- (1) become two times
(2) become four times
(3) remain same
(4) be halved

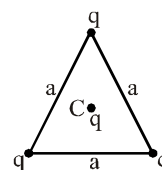
12. Three equal charges Q are placed at the vertices of an equilateral triangle. What should be the value of a charge so that when placed at the centroid, self energy of the system becomes zero.

- (1) $\frac{-Q}{2}$ (2) $\frac{-Q}{3}$ (3) $\frac{-Q}{2\sqrt{3}}$ (4) $\frac{-Q}{\sqrt{3}}$

13. The force acting between two point charges $+q$ and $+q$ separated by distance r is F . If one charge is fixed and another charge completes two rounds in circular path around it, then work done will be:-

- (1) $F \times 4\pi r$ (2) $F \times 2r$
(3) Zero (4) $F \times \pi r^2$

14. Four equal charges of magnitude q are placed as shown in figure. Now the charge at center C is taken to infinite slowly, then work done by external force will be -



- (1) $\frac{-3kq^2}{a}$ (2) $\frac{-3\sqrt{3}kq^2}{a}$
(3) $\frac{-3kq^2}{a}(\sqrt{3}+1)$ (4) $\frac{3kq^2}{a}(\sqrt{3}+1)$

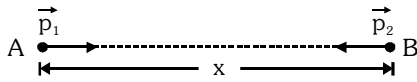
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ans	2	4	3	1	2	2	1	4	3	3	1	4	3	2

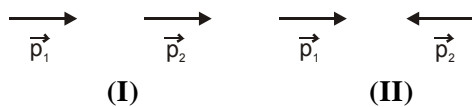
ELECTRIC DIPOLE

RACE # 05

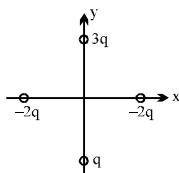
1. Two small electric dipoles, one of dipole moment $\vec{p}_1$ at point A and the other of dipole moment $\vec{p}_2$ at point B, are as shown in the figure. The torque experienced by the dipole $\vec{p}_2$ is :-



- (1) Zero (2) ∞
(3) Can't determined (4) None of these
2. For shown situation of two dipoles the nature of forces between them are :-



- (1) attraction, attraction
(2) attraction, repulsion
(3) repulsion, repulsion
(4) repulsion, attraction
3. The force of attraction between two co-axial dielectric dipoles whose centers are r meters apart varies with distance as
(1) r^{-1} (2) r^{-2} (3) r^{-3} (4) r^{-4}
4. A and B are two points on the axis and the perpendicular bisector respectively of an electric dipole. A and B are far away from the dipole and at equal distance from it. The field at A and B are $\vec{E}_A$ and $\vec{E}_B$.
(1) $\vec{E}_A = \vec{E}_B$
(2) $\vec{E}_A = 2\vec{E}_B$
(3) $\vec{E}_A = -2\vec{E}_B$
(4) $|E_B| = \frac{1}{2}|E_A|$, and $\vec{E}_B$ is perpendicular to $\vec{E}_A$
5. 4 charges are placed each at a distance 'a' from origin. The dipole moment of configuration is

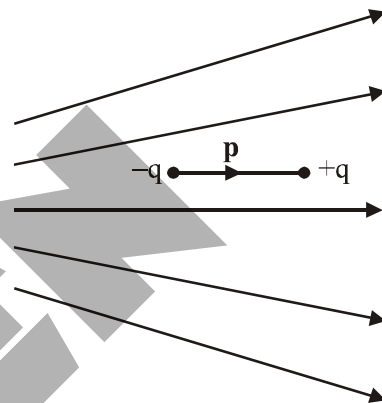


- (1) $2qa\hat{j}$ (2) $3qa\hat{j}$
(3) $2aq[\hat{i} + \hat{j}]$ (4) none

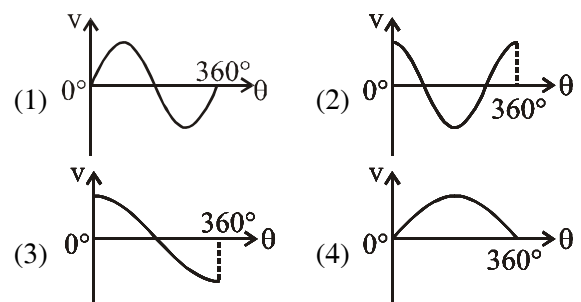
6. An electric dipole kept in a uniform electric field may experience :-

- (1) Only a torque
(2) Only a force
(3) A force and a torque
(4) None of the above

7. Figure shows electric field lines in which an electric dipole $\vec{p}$ is placed as shown. Which of the following statements is correct?



- (1) The dipole will not experience any force.
(2) The dipole will experience a force towards right.
(3) The dipole will experience a force towards left.
(4) The dipole will experience a force upwards.
8. A dipole is placed in uniform electric field such that potential energy of dipole is maximum (U). The work done in rotating a dipole by 180° is :-
(1) U (2) $3U$
(3) $-2U$ (4) $-U$
9. Consider a point A far away from short dipole p . By keeping r constant, θ varies from 0° to 360° . Variation of potential of dipole at A with respect to θ :-



10. Electric field at a far away distance r on the axis of dipole is $\vec{E}_0$. What is the electric field at a distance $2r$ on perpendicular bisector ?

- (1) $\frac{\vec{E}_0}{16}$
 (2) $-\frac{\vec{E}_0}{16}$
 (3) $\frac{\vec{E}_0}{8}$
 (4) $-\frac{\vec{E}_0}{8}$

Tg: @Chalnaayaaar

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	
Ans	1	2	4	3	1	1	3	3	2	2	

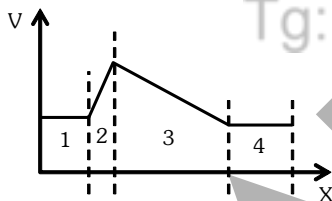
1. An alpha particle of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge Ze . Then the distance of closest approach for the alpha particle will be proportional to

(1) v^2 (2) $1/m$
(3) $1/v^4$ (4) $1/Ze$

2. A charge 3 coulomb experiences a force 3000 N when placed in a uniform electric field. The potential difference between two points separated by a distance of 1 cm along the field lines is

(1) 10 V (2) 90 V
(3) 1000 V (4) 9000V

3. In which region magnitude of x-component of electric field is maximum, if potential (V) versus distance(X), graph is as shown?



(1) 1 (2) 2 (3) 3 (4) 4

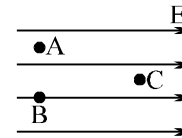
4. An electric field is expressed as $\vec{E} = 2\hat{i} + 3\hat{j}$. Find the potential difference ($V_A - V_B$) between two points A and B whose position vectors are given by $\vec{r}_A = \hat{i} + 2\hat{j}$ and $\vec{r}_B = 2\hat{i} + \hat{j} + 3\hat{k}$.

(1) -1V (2) 1 V
(3) 2 V (4) 3V

5. In a certain region of space, the potential is given by : $V = k[2x^2 - y^2 + z^2]$. The electric field at the point (1, 1, 1) has magnitude =

(1) $k\sqrt{6}$ (2) $2k\sqrt{6}$
(3) $2k\sqrt{3}$ (4) $4k\sqrt{3}$

6. Suppose a region of space has a uniform electric field, directed towards the right, as shown below. Which statement is true?

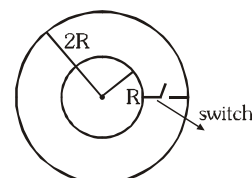


- (1) The potential at all three locations is the same
(2) The potential at points A and B are equal and the potential at point C is higher than the potential at point A
(3) The potential at points A and B are equal, and the potential at point C is lower than the potential at point A
(4) The potential at point A is the highest, the potential at point B is the second highest, and the potential at point C is the lowest.

7. Electric field in a region is directed outwards and proportional to distance r from origin. Taking potential at origin to be zero, potential in the region is :

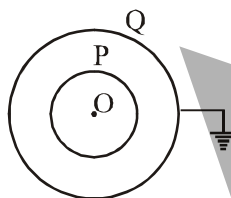
- (1) Uniform
(2) Proportional to r
(3) Proportional to r^2
(4) Increases as we move away from origin.

8. Net positive charge on inner spherical conductor is $3Q$ and on outer spherical conductor is Q . When switch is closed :-



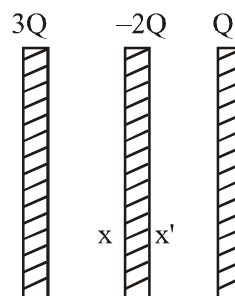
- (1) Charge will flow from inner shell to outer shell
(2) Charge will flow from outer shell to inner shell
(3) Charge will not flow
(4) None of these

9. If a net charge is given to a solid conducting sphere then
- it must be distributed uniformly in its volume
 - it may be distributed uniformly in its volume
 - must be distributed uniformly on its surface
 - the distribution would depend on whether other charges are present or not
10. A number of spherical conductors of different radii have same potential. Then the surface charge density on them
- is proportional to their radii
 - is inversely proportional to their radii
 - are equal
 - is proportional to square of their radii
11. Eight dipoles of charges of magnitude 'q' are placed inside a cube. The total electric flux coming out of the cube is
- $8q/\epsilon_0$
 - $16q/\epsilon_0$
 - q/ϵ_0
 - zero
12. P and Q are two concentric metallic shells. If P is positively charged and Q is earthed. then:-

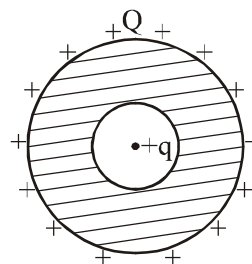


- charge density on Q is same as on P
 - electric field between P & Q is uniform
 - electric potential inside P is zero
 - electric field outside Q is zero
13. An electron and proton projected perpendicular to uniform electric field at a same point with equal kinetic energy then which is correct for their deflection :-
- equal and in opposite direction
 - unequal and in same direction
 - equal and in same direction
 - unequal and in opposite direction

14. Charge on both surfaces of middle metal plate :-

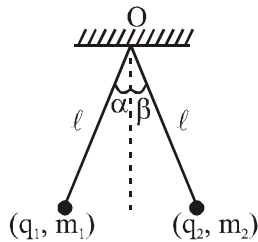


- $x = -2Q, x' = 0$
 - $x = +2Q, x' = 0$
 - $x = -2Q, x' = +4Q$
 - $x = -4Q, x' = +2Q$
15. 64 small drops of mercury, each of radius r and charge q are mixed together to form a big drop. The ratio of surface charge density of each small drop to big drop is :-
- 64 : 1
 - 1 : 64
 - 1 : 4
 - 4 : 1
16. A metallic conductor with a cavity is shown in figure. A point charge +q inserted into cavity, keeping insulated from conductor. The total charge on outer surface of conductor :-



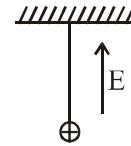
- Q
 - $(Q - q)$
 - $(Q + q)$
 - q
17. A sensitive instrument is to be shielded from strong electrostatic field in its environment then it must be enclosed fully by :-
- non conducting surface
 - metallic surface
 - Gaussian surface
 - Dielectric surface

18. Figure shows suspended charge ball system. If $\alpha > \beta$ then at equilibrium which of following may be true :-



- (1) $q_1 > q_2$ & $m_1 = m_2$ (2) $q_1 = q_2$ & $m_1 = m_2$
(3) $q_1 > q_2$ & $m_1 < m_2$ (4) $q_1 = q_2$ & $m_1 > m_2$

19. A positively charged ball of a simple pendulum is oscillating in vertical uniform electric field as shown in figure. The time period as compared to then when it was uncharged :-



- (1) will be less
(2) will be more
(3) will remain unchanged
(4) will first increases and then decreases

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	2	1	2	1	2	3	3	1	4	2	4	4	1	1	3
Que.	16	17	18	19											
Ans	3	2	3	2											

1. A potential difference V exists between the ends of a metal wire of length ℓ . The drift velocity will be doubled if :-
 - (1) V is doubled
 - (2) ℓ is doubled
 - (3) The diameter of the wire is doubled
 - (4) The temperature of the wire is doubled
2. Three copper wires have their lengths in the ratio $5 : 3 : 1$ and their masses are in the ratio $1 : 3 : 5$. Their electrical resistance will be in the ratio
 - (1) $5 : 3 : 1$
 - (2) $1 : 3 : 5$
 - (3) $125 : 15 : 1$
 - (4) $1 : 15 : 125$
3. A cylindrical copper wire is stretched such that its diameter decreases by 0.01% . The approximate percentage increase in its resistance is :-
 - (1) 0.02%
 - (2) 0.04%
 - (3) 0.08%
 - (4) 0.16%
4. The resistance of wire is 5Ω at 50°C & 6Ω at 100°C . The resistance of the wire at 0°C will be :-
 - (1) 2Ω
 - (2) 1Ω
 - (3) 4Ω
 - (4) 3Ω

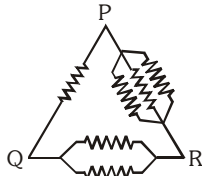
ANSWER KEY

Que.	1	2	3	4	
Ans	1	3	2	3	

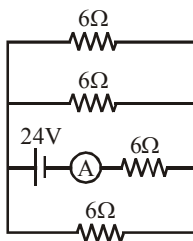
CURRENT ELECTRICITY : COMBINATION OF RESISTANCE, KVL & KCL RACE # 02

1. Six equal resistances are connected between points P, Q and R as shown in the figure. Then, the net resistance will be maximum between

- (1) P and Q
(2) Q and R
(3) P and R
(4) any two points

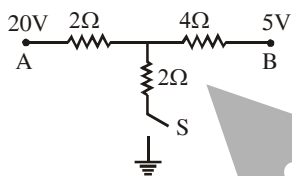


2. Reading of ammeter in the circuit below is :



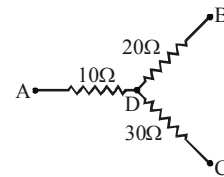
- (1) 16 A (2) 3 A
(3) 4 A (4) 12 A

3. As the switch S is closed in the circuit shown in figure, current passed through it is :-



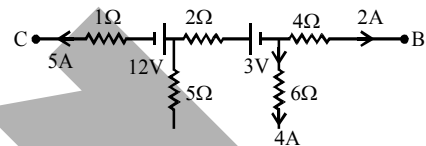
- (1) 4.5 A (2) 6.0 A (3) 3.0 A (4) Zero

4. In the circuit given here, the points A, B and C are 70 V, 0, 10V respectively. Then



- (1) the point D will be at a potential of 60V
(2) the point D will be at a potential of 20V
(3) currents in the paths AD, DB and DC are in the ratio of 9:2:3
(4) currents in the paths AD, DB and DC are in the ratio of 3:2:1

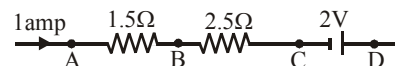
5. The figure shows part of certain circuit, find :



Potential difference $V_C - V_B$.

- (1) 6 V (2) 10 V
(3) 4 V (4) 8 V

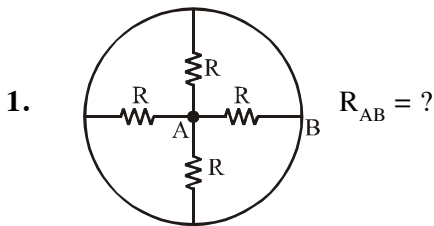
6. In the circuit element given here, if the potential at point B, $V_B = 0$, then the potentials of A and D are given as:-



- (1) $V_A = -1.5V$, $V_D = +2V$
(2) $V_A = +1.5V$, $V_D = +2V$
(3) $V_A = +1.5V$, $V_D = +0.5V$
(4) $V_A = +1.5V$, $V_D = -0.5V$

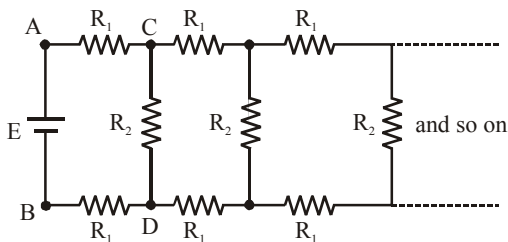
ANSWER KEY

Que.	1	2	3	4	5	6	
Ans	1	2	1	4	1	4	



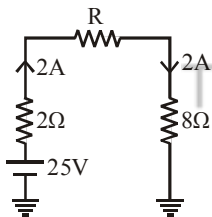
- (1) $R/4$ (2) $R/2$ (3) R (4) $2R$

2. Find the equivalent resistance between A and B of the network extending off to the infinity shown in the figure for $R_1 = 1\Omega$, $R_2 = 4\Omega$:-



- (1) 4Ω (2) 1Ω (3) 2Ω (4) 8Ω

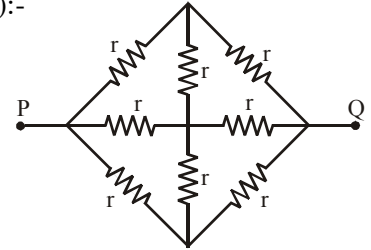
3. The value of R in the circuit should be :-



- (1) 1Ω (2) 1.5Ω (3) 2Ω (4) 2.5Ω

4. The equivalent resistance between the points P and Q in the network given here is equal to

(given $r = \frac{3}{2}\Omega$):-



- (1) $\frac{1}{2}\Omega$
(2) 1Ω
(3) $\frac{3}{2}\Omega$
(4) 2Ω

5. n identical cells are joined in series with its two cells A and B in the loop with reversed polarities. EMF of each cell is E and internal resistance r . Potential difference across cell A or B is (here $n > 4$)

- (1) $\frac{2E}{n}$ (2) $2E\left(1 - \frac{1}{n}\right)$
(3) $\frac{4E}{n}$ (4) $2E\left(1 - \frac{2}{n}\right)$

6. Two cells of equal e.m.f. and of internal resistances r_1 and r_2 ($r_1 > r_2$) are connected in series. On connecting this combination to an external resistance R , it is observed that the potential difference across the first cell becomes zero. The value of R will be

- (1) $r_1 + r_2$ (2) $r_1 - r_2$
(3) $\frac{r_1 + r_2}{2}$ (4) $\frac{r_1 - r_2}{2}$

ANSWER KEY

Que.	1	2	3	4	5	6	
Ans	1	1	4	2	4	2	

CURRENT ELECTRICITY : POWER & HEATING EFFECT

RACE # 04

1. A battery of internal resistance 2Ω is connected to a variable resistor whose value can vary from 4Ω to 10Ω . The resistance is initially set at 4Ω . If the resistance is now increased then—
 - (1) power consumed by it will decrease
 - (2) power consumed by it will increase
 - (3) power consumed by it may increase or may decrease
 - (4) power consumed will first increase then decrease
2. n identical bulbs are rated P watt and V volt. When they are connected in series, total power consumed is 20 watt and when connected in parallel they consume total power of 2000 watt. How many bulbs are used :-
 - (1) 200 bulbs
 - (2) 100 bulbs
 - (3) 20 bulbs
 - (4) 10 bulbs
3. An electric tea kettle has two heating coils. When one of the two coils is switched on, the tea begins to boil in 10 minutes. When second coil only is switched on, the boiling begins in 15 minutes. When both coils are connected in parallel and switched on the tea starts boiling in time t , then t is :-
 - (1) 4 minute
 - (2) 6 minute
 - (3) 25 minute
 - (4) 12 minute
4. Of the two bulbs in a house hold circuit, one glows brighter than the other, which of the two bulbs has a large resistance ?
 - (1) The bright bulb
 - (2) The dim bulb
 - (3) Both have the same resistance
 - (4) The brightness does not depend upon the resistance
5. Two electric bulbs whose resistance are in the ratio of $1 : 2$, are connected in series to a constant voltage source. The power dissipated in them has the ratio :-
 - (1) $1 : 2$
 - (2) $1 : 1$
 - (3) $1 : 4$
 - (4) $2 : 1$
6. If two bulbs of wattage 60 W and 100 W respectively each rated at 110 V are connected in series with the supply of 220 V , which bulb will fuse ?
 - (1) 60 W bulb
 - (2) 100 W bulb
 - (3) Both the bulbs
 - (4) Bulbs will not fuse

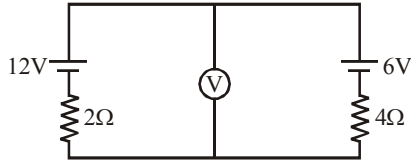
ANSWER KEY

Que.	1	2	3	4	5	6	
Ans	1	4	2	2	1	1	

CURRENT ELECTRICITY : ELECTRICAL INSTRUMENTS

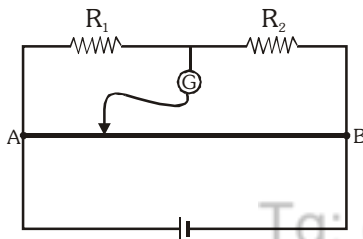
RACE # 05

1. Reading of the ideal voltmeter in the circuit below is :



- (1) 10 V (2) 8 V
(3) 6 V (4) Zero

2. In the figure shown for gives values of R_1 and R_2 the balance point for Jockey is at 40 cm from A. When R_2 is shunted by a resistance of 10Ω , balanced shifts to 50 cm. R_1 and R_2 are ($AB = 1m$):



- (1) $\frac{10}{3}\Omega$, 5Ω
(2) 20Ω , 30Ω
(3) 10Ω , 15Ω
(4) 5Ω , $\frac{15}{2}\Omega$

3. Two resistances of 100Ω and 200Ω are connected in series with a battery of emf 4 volt and negligible internal resistance. A voltmeter of resistance 200Ω is used to measure voltage across the two resistance separately. Calculate the voltage indicated when voltmeter connected across 100Ω :-

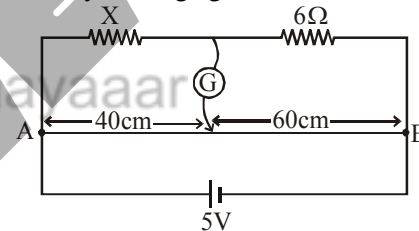
- (1) 1 V (2) 2 V (3) 3 V (4) 4 V

4. When two cells of emf E_1 and E_2 are connected in series, the null point across potentiometer wire is obtained at 60 cm. When polarity of one cell is reversed null point is obtained at 40 cm.

Hence $\frac{E_1}{E_2}$ is equal to :- (Consider $E_1 > E_2$)

- (1) 1 : 5 (2) 5 : 1 (3) 3 : 2 (4) 2 : 3

5. In the circuit shown, a meter bridge is in its balanced state. The meter bridge wire has a resistance 0.1 ohm/cm . The value of unknown resistance X and the current drawn from the battery of negligible resistance is :-



- (1) 6Ω , 5.0 amp (2) 10Ω , 0.1 amp
(3) 4Ω , 1.0 amp (4) 12Ω , 0.5 amp

ANSWER KEY

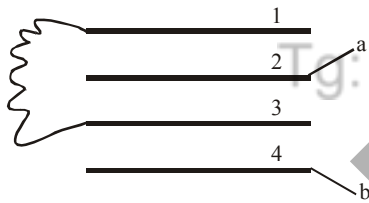
Que.	1	2	3	4	5
Ans	1	1	1	2	3

CAPACITOR (PARALLEL PLATE CAPACITOR)

RACE # 01

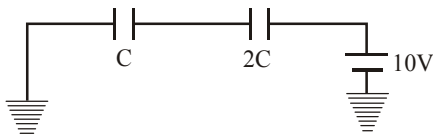
1. If the plates of a parallel plate capacitor are not equal in area, then quantity of charge :-
- (1) On the plates will be same but nature of charge will differ
 - (2) On the plates as well as nature of charge will be different
 - (3) On the plates will be different but nature of charge will be same
 - (4) As well as nature of charge will be same

2. Consider the following arrangement of four plates interconnected as follows. Each plate has the area A and the plate separation is d . Here plates 1 and 3 are interconnected. Find the equivalent capacitance between a and b :



- (1) $\frac{3\epsilon_0 A}{2d}$
- (2) $\frac{2\epsilon_0 A}{3d}$
- (3) $\frac{3\epsilon_0 A}{d}$
- (4) $\frac{1\epsilon_0 A}{3d}$

3. In the circuit shown in the figure, $C = 6 \mu\text{F}$. The charge stored in the capacitor of capacity C is:

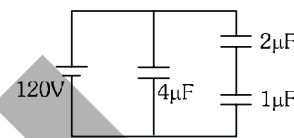


- (1) zero
- (2) $90 \mu\text{C}$
- (3) $40 \mu\text{C}$
- (4) $60 \mu\text{C}$

4. Capacity of the capacitor of plates area A_1 and A_2 ($A_2 < A_1$) placed in front of each other is given by (plate separation is d)

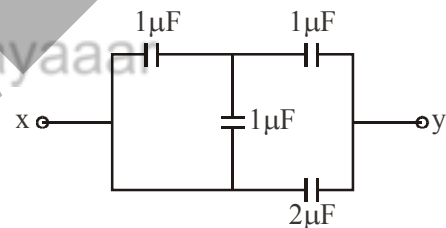
- (1) $\frac{\epsilon_0 A_1}{d}$
- (2) $\frac{\epsilon_0 A_2}{d}$
- (3) $\frac{\epsilon_0 (A_1 - A_2)}{d}$
- (4) $\frac{\epsilon_0 (A_1 + A_2)}{2d}$

5. In the circuit shown charge on $2\mu\text{F}$ capacitor is



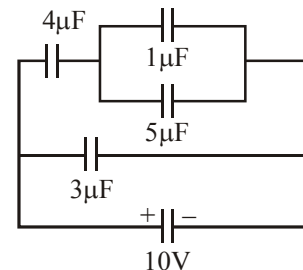
- (1) $160 \mu\text{C}$
- (2) $80 \mu\text{C}$
- (3) $40 \mu\text{C}$
- (4) $20 \mu\text{C}$

6. Find net capacitance between X and Y :



- (1) $\frac{5}{6} \mu\text{F}$
- (2) $\frac{7}{6} \mu\text{F}$
- (3) $\frac{8}{3} \mu\text{F}$
- (4) $1 \mu\text{F}$

7. For the circuit shown in the figure, the charge on $4\mu\text{F}$ capacitor is :-



- (1) $30 \mu\text{C}$
- (2) $40 \mu\text{C}$
- (3) $24 \mu\text{C}$
- (4) $54 \mu\text{C}$

ANSWER KEY

Que.	1	2	3	4	5	6	7
Ans	1	2	3	2	2	3	3

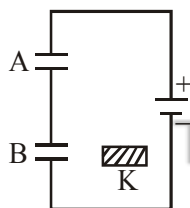
CAPACITOR (DIELECTRIC/SPHERICAL/RC CIRCUIT)

RACE # 02

1. Energy E is stored in a parallel plate capacitor C_1 . An identical uncharged capacitor C_2 is connected to it, kept in contact with it for a while and then disconnected. The energy stored in C_2 is :-

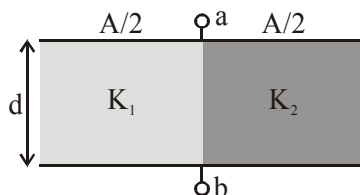
- (1) $\frac{E}{2}$ (2) $\frac{E}{3}$
(3) $\frac{E}{4}$ (4) Zero

2. Two identical capacitors A and B shown in the given circuit are joined in series with a battery. If a dielectric slab of dielectric constant K is slipped between the plates of capacitors B and battery remains connected, then the energy of capacitor A will :-



- (1) decrease
(2) increase
(3) remain the same
(4) be zero since circuit will not work

3. The capacity of a parallel plate air capacitor is $10\mu\text{F}$. As shown in the figure this capacitor is divided into two equal parts, these parts are filled by media of dielectric constants $K_1=2$ and $K_2=4$, capacity of this arrangement will be :-

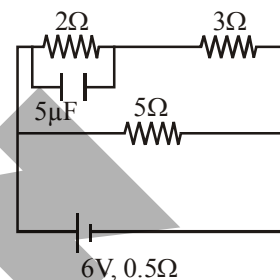


- (1) $20\mu\text{F}$ (2) $30\mu\text{F}$
(3) $10\mu\text{F}$ (4) $40\mu\text{F}$

4. When slab of dielectric medium is placed between plates of a parallel plate capacitor which is connected with battery then electric field between the plates in comparison with earlier field :-

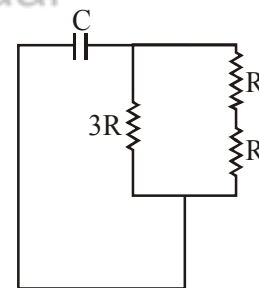
- (1) Is same (2) Is less
(3) Is more (4) Can't say

5. Find out amount of charge on capacitor shown in circuit.



- (1) $0\mu\text{C}$ (2) $30\mu\text{C}$
(3) $10\mu\text{C}$ (4) $25\mu\text{C}$

6. The time constant of the given circuit is :



- (1) $\frac{3RC}{5}$ (2) $\frac{6RC}{5}$
(3) $\frac{5RC}{6}$ (4) None of the above

7. A capacitor charges from a cell through a resistance. The time constant is τ . In what time will the capacitor collect 10% of its final charge:-

- (1) $\tau \ln(0.1)$ (2) $\tau \ln(0.9)$
(3) $\tau \ln(10/9)$ (4) $\tau \ln(11/10)$

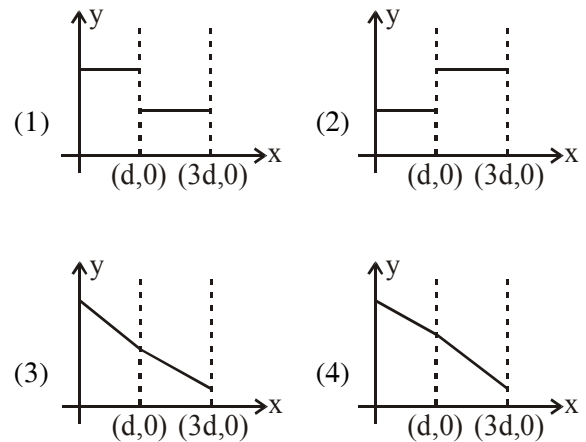
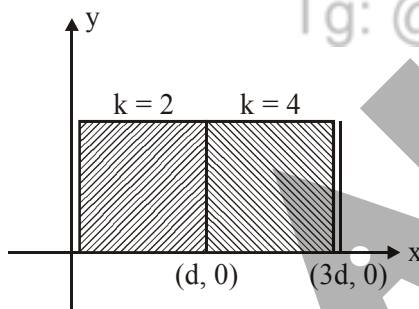
ANSWER KEY

Que.	1	2	3	4	5	6	7
Ans	3	2	2	1	3	2	3

CAPACITOR (MISCELLANEOUS)

RACE # 03

- An air-filled parallel plate capacitor is to be constructed which can store $12\mu\text{C}$ of charge when operated at 1200V . What can be the minimum plate area of the capacitor ?
[Dielectric strength of air = $3 \times 10^6 \text{V/m}$] :-
(1) 0.38 cm^2
(2) 0.30 m^2
(3) 0.45 cm^2
(4) 0.45 m^2
- A charge of $20\mu\text{C}$ is placed on the positive plate of an isolated parallel-plate capacitor of capacitance $10\mu\text{F}$ then potential developed between the plates :-
(1) 1V (2) 2V (3) 3V (4) 4V
- A parallel plate capacitor has two layers of dielectric as shown in figure. This capacitor is connected across a battery. The graph which shows the variation of electric field (E) and distance (x) from left plate :-



- A $20\mu\text{F}$ capacitor in a defibrillator is charged to 2000V . The energy stored in the capacitor is sent through the patient during a pulse of duration 4ms the power delivered to the patient is :-
(1) 10 kW (2) 20 kW
(3) 30 kW (4) 40 kW

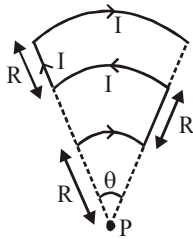
ANSWER KEY

Que.	1	2	3	4
Ans	4	1	1	1

MAGNETIC EFFECT OF CURRENT AND MAGNETISM

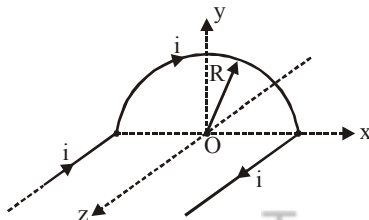
RACE # 01

1. Magnetic field at P due to given structure is :-



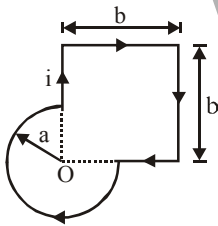
- (1) $\left(\frac{\mu_0}{4\pi}\right) \frac{I\theta}{2R}$ (2) $\frac{\mu_0}{4\pi} \frac{6I\theta}{5R}$
(3) $\left(\frac{\mu_0}{4\pi}\right) \frac{5I\theta}{6R}$ (4) $\left(\frac{\mu_0}{4\pi}\right) \frac{2I\theta}{R}$

2. The magnetic induction at the point O, if the wire carries a current i, is :-



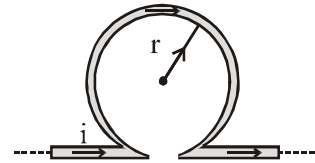
- (1) $\frac{\mu_0 i}{2R}$ (2) $\frac{\mu_0 i}{2\pi R}$
(3) $\frac{\mu_0 i(\pi^2 + 4)^{1/2}}{4\pi R}$ (4) $\frac{\mu_0 i(\pi^2 + 4)}{4\pi R}$

3. The magnetic field at the point O of a loop with current i, whose shape is illustrated below is :-



- (1) $\frac{\mu_0 i}{4\pi} \left[\frac{3\pi}{2a} + \frac{\sqrt{2}}{b} \right]$
(2) $\frac{\mu_0 i}{4\pi^2} \left[\frac{2}{b} + b \right]$
(3) $\frac{\mu_0 i}{2\pi^2} \left[\frac{1}{a} + \frac{1}{b} \right]$
(4) $\frac{\mu_0 i}{4\pi} \left[\frac{1}{a} + \frac{1}{b} \right]$

4. An infinitely long straight conductor is bent into the shape as shown in the figure. It carries a current of i ampere and the radius of the circular loop is r metre. Then the magnetic induction at its centre will be



- (1) $\frac{\mu_0 I}{2\pi r} (\pi + 1)$ (2) $\frac{\mu_0 I}{2\pi r} (\pi - 1)$
(3) Zero (4) Infinite

5. The magnetic induction at a point P which is distant 4 cm from a long current carrying wire is 10^{-8} Tesla. Magnetic induction at a distance 12 cm from the same current carrying wire would be

- (1) 3.33×10^{-9} Tesla (2) 1.11×10^{-4} Tesla
(3) 3×10^{-3} Tesla (4) 9×10^{-2} Tesla

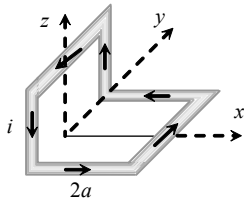
6. Two concentric circular coils of ten turns each are situated in the same plane. Their radii are 20 and 40 cm and they carry respectively 0.2 and 0.3 ampere current in opposite direction. The magnetic field in weber/m² at the centre is

- (1) $\frac{35}{4} \mu_0$ (2) $\frac{\mu_0}{80}$
(3) $\frac{7}{80} \mu_0$ (4) $\frac{5}{4} \mu_0$

7. A cell is connected between two points of a uniformly thick circular conductor. The magnetic field at the centre of the loop will be (Here i_1 and i_2 are the currents flowing in the two parts of the circular conductor of radius 'a' And μ_0 has the usual meaning)

- (1) Zero (2) $\frac{\mu_0}{2a} (i_1 - i_2)$
(3) $\frac{\mu_0}{2a} (i_1 + i_2)$ (4) $\frac{\mu_0}{a} (i_1 + i_2)$

8. A non-planar loop of conducting wire carrying a current I is placed as shown in the figure. Each of the straight sections of the loop is of length $2a$. The magnetic field due to this loop at the point $P(a, 0, a)$ points in the direction



- (1) $\frac{1}{\sqrt{2}}(-\hat{j} + \hat{k})$ (2) $\frac{1}{\sqrt{3}}(-\hat{j} + \hat{k} + \hat{i})$
 (3) $\frac{1}{\sqrt{3}}(\hat{i} + \hat{j} + \hat{k})$ (4) $\frac{1}{\sqrt{2}}(\hat{i} + \hat{k})$

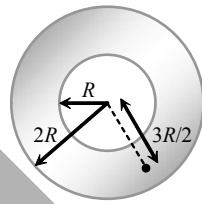
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ANSWER KEY

Que.	1	2	3	4	5	6	7	8	
Ans	3	3	1	2	1	4	1	4	

MAGNETIC EFFECT OF CURRENT AND MAGNETISM

RACE # 02

- A current i ampere flows along the inner conductor of long coaxial cable and returns along the outer conductor of the cable, then the magnetic induction at any point outside the conductor at a distance r metre from the axis is
 (1) ∞ (2) Zero
 (3) $\frac{\mu_0 I}{2\pi r}$ (4) $\frac{\mu_0 I}{2r}$
- There are 50 turns of a wire in every cm length of a long solenoid. If 4 ampere current is flowing in the solenoid, the approximate value of magnetic field along its axis at an internal point and at one end will be respectively
 (1) 12.6×10^{-3} Weber/m², 6.3×10^{-3} Weber/m²
 (2) 12.6×10^{-3} Weber/m², 25.1×10^{-3} Weber/m²
 (3) 25.1×10^{-3} Weber/m², 12.6×10^{-3} Weber/m²
 (4) 25.1×10^{-5} Weber/m², 12.6×10^{-5} Weber/m²
- The current in the windings on a toroid is 2.0A. There are 400 turns and the mean circumferential length is 40cm. If the inside magnetic field is 1.0T, the relative permeability is near to :-
 (1) 100 (2) 200 (3) 300 (4) 400
- Figure shows the cross-sectional view of the hollow cylindrical conductor with inner radius ' R ' and outer radius ' $2R$ ', cylinder carrying uniformly distributed current along its axis. The magnetic induction at point ' P ' at a distance $\frac{3R}{2}$ from the axis of the cylinder will be

 (1) Zero (2) $\frac{5\mu_0 i}{72\pi R}$
 (3) $\frac{7\mu_0 i}{18\pi R}$ (4) $\frac{5\mu_0 i}{36\pi R}$
- A long straight wire carries a current. Can Ampere's circuital law be used to find magnetic field on a loop that doesn't enclose the wire :-
 (1) Yes, if loop is circular
 (2) Yes, if loop is rectangular
 (3) Yes, if loop is of irregular shape
 (4) No

ANSWER KEY

Que.	1	2	3	4	5	
Ans	2	3	4	4	4	

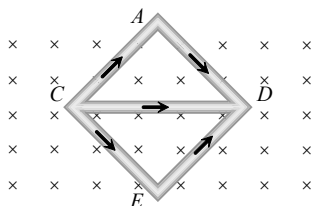
MAGNETIC EFFECT OF CURRENT AND MAGNETISM

RACE # 03

- A proton (mass m and charge $+e$) and an α -particle (mass $4m$ and charge $+2e$) are projected with the same kinetic energy at right angles to the uniform magnetic field. Which one of the following statements will be true
 - The α -particle will be bent in a circular path with a small radius that for the proton
 - The radius of the path of the α -particle will be greater than that of the proton
 - The α -particle and the proton will be bent in a circular path with the same radius
 - The α -particle and the proton will go through the field in a straight line
- An electron is moving with a speed of 10^8 m/sec perpendicular to a uniform magnetic field of intensity B . Suddenly intensity of the magnetic field is reduced to $B/2$. The radius of the path becomes from the original value of r
 - No change
 - Reduces to $r/2$
 - Increases to $2r$
 - Stops moving
- A proton and an α -particle enter a uniform magnetic field perpendicularly with the same speed. If proton takes 25μ sec to make 5 revolutions, then the periodic time for the α -particle would be
 - 50μ sec
 - 25μ sec
 - 10μ sec
 - 5μ sec
- If a particle of charge 10^{-12} C moving along the $\hat{x}$ -direction with a velocity 10^5 m/s experiences a force of 10^{-10} N in $\hat{y}$ -direction due to magnetic field, then the minimum magnetic field is
 - 6.25×10^3 T in $\hat{z}$ -direction
 - 10^{-15} T in $\hat{z}$ -direction
 - 6.25×10^{-3} T in $\hat{z}$ -direction
 - 10^{-3} T in $\hat{z}$ -direction
- A beam of well collimated cathode rays travelling with a speed of 5×10^6 ms $^{-1}$ enter a region of mutually perpendicular electric and magnetic fields and emerge undeviated from this region. If $|\mathbf{B}| = 0.02$ T, the magnitude of the electric field is
 - 10^5 Vm $^{-1}$
 - 2.5×10^8 Vm $^{-1}$
 - 1.25×10^{10} Vm $^{-1}$
 - 2×10^3 Vm $^{-1}$
- Two ions having masses in the ratio 1 : 1 and charges 1 : 2 are projected into uniform magnetic field perpendicular to the field with speeds in the ratio 2 : 3. The ratio of the radii of circular paths along which the two particles move is
 - 4 : 3
 - 2 : 3
 - 3 : 1
 - 1 : 4
- 3 A of current is flowing in a linear conductor having a length of 40 cm. The conductor is placed in a magnetic field of strength 500 gauss and makes an angle of 30° with the direction of the field. It experiences a force of magnitude
 - 3×10^4 N
 - 3×10^2 N
 - 3×10^{-2} N
 - 3×10^{-4} N
- Three long, straight and parallel wires carrying currents are arranged as shown in the figure. The wire C which carries a current of 5.0 amp is so placed that it experiences no force. The distance of wire C from wire D is then

 - 9 cm
 - 7 cm
 - 5 cm
 - 3 cm

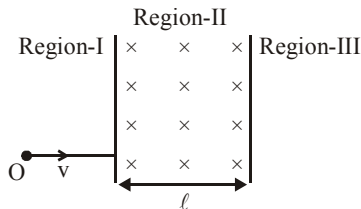
9. Same current $i = 2A$ is flowing in a wire frame as shown in figure. The frame is a combination of two equilateral triangles ACD and CDE of side $1m$. It is placed in uniform magnetic field $B = 4T$ acting perpendicular to the plane of frame. The magnitude of magnetic force acting on the frame is



- (1) $24 N$ (2) Zero (3) $16 N$ (4) $8 N$
10. A charged particle is whirled in a horizontal circle on a frictionless table by attaching it to a string fixed at one point. If a magnetic field is switched on in the vertical direction, the tension in the string :-
- (1) Will increase
(2) Will decrease
(3) Will remain the same
(4) May increase or decrease
11. An electron accelerated through a potential difference V enters a uniform transverse magnetic field and experiences a force F . If the accelerating potential is increased to $2V$, the electron in the same magnetic field will experience a force :-
- (1) F (2) $\frac{F}{2}$
(3) $\sqrt{2} F$ (4) $2 F$
12. A proton is projected with a velocity 10^7 m/s, at right angles to a uniform magnetic field of induction 100 mT. The time (in second) taken by the proton to traverse 90° arc is ($m_p = 1.65 \times 10^{-27}$ kg and $q_p = 1.6 \times 10^{-19}$ C) :-
- (1) 0.81×10^{-7} (2) 1.62×10^{-7}
(3) 2.43×10^{-7} (4) 3.24×10^{-7}

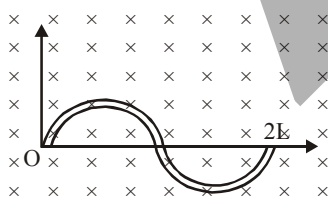
13. If a charged particle goes unaccelerated in a region containing electric and magnetic fields, then :-
- (1) $\vec{E}$ must be perpendicular to $\vec{B}$
(2) $\vec{v}$ must be perpendicular to $\vec{E}$
(3) $\vec{v}$ must be perpendicular to $\vec{B}$
(4) E must be equal to vB
14. In a cyclotron, if a deuteron can gain an energy of 40 MeV, then a proton can gain an energy of :-
- (1) 40 MeV (2) 80 MeV
(3) 20 MeV (4) 160 MeV
15. A particle with a specific charge's' is fired with a speed v towards a wall at a distance d , perpendicular to the wall. What minimum magnetic field must exist in this region for the particle not to hit the wall :-
- (1) $\frac{v}{sd}$ (2) $\frac{2v}{sd}$
(3) $\frac{v}{2sd}$ (4) $\frac{v}{4sd}$
16. A particle of charge per unit mass α is projected from origin with a velocity $\vec{v} = v_0 \hat{i}$ in a uniform magnetic field $\vec{B} = -B_0 \hat{k}$. If the particle passes through $(0, y, 0)$ then y is equal to :-
- (1) $-\frac{2v_0}{B_0\alpha}$ (2) $\frac{v_0}{B_0\alpha}$
(3) $\frac{2v_0}{B_0\alpha}$ (4) $-\frac{v_0}{B_0\alpha}$
17. A charged particle enters in a magnetic field at right angles to the magnetic field. The field exists for a length equal to 1.5 times the radius of circular path of the particle. The particle will be deviated from its path by :-
- (1) 90° (2) $\sin^{-1}\left(\frac{2}{3}\right)$
(3) 30° (4) 180°

18. A particle of mass m and charge q moving with velocity $v < \frac{qB\ell}{m}$ enters region-II normal to the boundary as shown in the figure. Region-II has a uniform magnetic field B perpendicular to the plane of paper. The particle will :-



- (1) Enter the region-III
(2) Not enter the region-III
(3) Complete circular motion in region-II
(4) Move undeflected in region-II
19. A small circular flexible loop of wire of radius R carries a current I . It is placed in a uniform magnetic field B . The tension in the loop will be doubled, if :-
- (1) I is doubled (2) B is doubled
(3) R is doubled (4) All of these
20. A wire carrying a current i is placed in a uniform magnetic field 'B'. This wire is in the form of the

curve $y = a \sin\left(\frac{\pi x}{L}\right)$ $0 \leq x \leq 2L$. Force acting on the wire is :-



- (1) $\frac{iBL}{\pi}$ (2) $iBL\pi$
(3) $2iBL$ (4) Zero

21. The magnetic field existing in a region is given

by $\vec{B} = B_0 \left(1 + \frac{x}{\ell}\right) \hat{k}$. A square loop of edge ℓ and carrying a current i , is placed with its edge parallel to the x-y axes. Find the magnitude of the net magnetic force experienced by the square loop :-

- (1) $\frac{1}{2} iB_0\ell$ (2) Zero (3) $iB_0\ell$ (4) $2iB_0\ell$

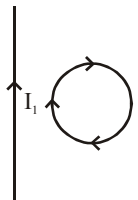
22. To make the magnetic field radial in a moving coil galvanometer :-

- (1) The number of turns in the coil is increased
(2) Magnet is taken in the form of horse-shoe
(3) Poles are cylindrically cut
(4) Coil is wound on aluminium frame

23. In the given figure, the loop is fixed but straight wire can move.

The straight wire will :-

- (1) Remain stationary
(2) Move towards the loop
(3) Move away from the loop
(4) Rotate about the axis



24. If two straight current carrying wires are kept in a same plane perpendicular to each other almost touching, then the wires :-

- (1) Attract each other
(2) Repel each other
(3) Remain stationary
(4) Finally become parallel to each other

25. Suppose an isolated north pole is kept at the centre of a circular loop carrying a electric current i . The magnetic field due to the north pole at a point on the periphery of the wire is B . The radius of the loop is a . The force on the wire is :-

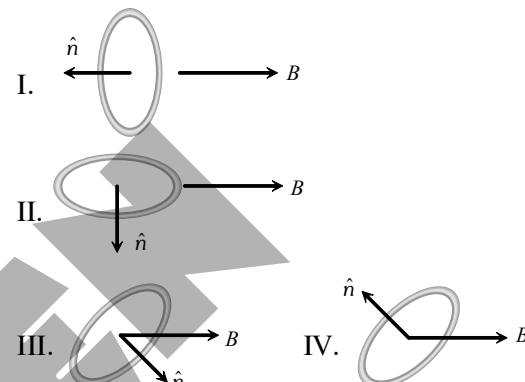
- (1) Nearly $2\pi a i B$ perpendicular to the plane of loop
(2) $2\pi a i B$ perpendicular to the plane of loop
(3) $\pi a i B$ along the axis of the loop
(4) Zero

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	3	3	3	4	1	1	3	1	1	4	3	2	1,2	2	1
Que.	16	17	18	19	20	21	22	23	24	25					
Ans	3	4	2	4	3	3	3	2	4	2					

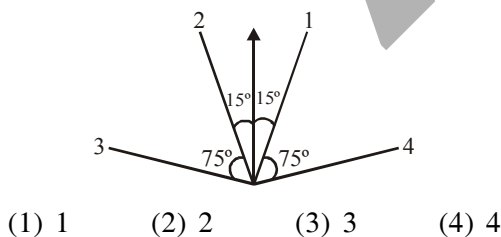
MAGNETIC EFFECT OF CURRENT AND MAGNETISM

RACE# 04

- The magnetic moment of a current carrying loop is $2.1 \times 10^{-25} \text{ amp} \times \text{m}^2$. The magnetic field at a point on its axis at a distance of $1 \text{ \AA}$ is
 (1) $4.2 \times 10^{-2} \text{ weber / m}^2$ (2) $4.2 \times 10^{-3} \text{ weber / m}^2$
 (3) $4.2 \times 10^{-4} \text{ weber / m}^2$ (4) $4.2 \times 10^{-5} \text{ weber / m}^2$
- In a hydrogen atom, an electron moves in a circular orbit of radius $5.2 \times 10^{-11} \text{ m}$ and produces a magnetic induction of 12.56 T at its nucleus. The current produced by the motion of the electron will be (Given $\mu_0 = 4\pi \times 10^{-7} \text{ Wb / A-m}$)
 (1) $6.53 \times 10^{-3} \text{ ampere}$ (2) $13.25 \times 10^{-10} \text{ ampere}$
 (3) $9.6 \times 10^6 \text{ ampere}$ (4) $1.04 \times 10^{-3} \text{ ampere}$
- The earth's magnetic induction at a certain point is $7 \times 10^{-5} \text{ Wb / m}^2$. This is to be annulled by the magnetic induction at the centre of a circular conducting loop of radius 5 cm . The required current in the loop is
 (1) 0.56 A (2) 5.6 A
 (3) 0.28 A (4) 2.8 A
- Two wires of same length are shaped into a square and a circle. If they carry same current, ratio of the magnetic moment is
 (1) $2 : \pi$ (2) $\pi : 2$ (3) $\pi : 4$ (4) $4 : \pi$
- A circular coil of radius 4 cm has 50 turns. In this coil a current of 2 A is flowing. It is placed in a magnetic field of 0.1 weber / m^2 . The amount of work done in rotating it through 180° from its stable equilibrium position will be
 (1) 0.1 J (2) 0.2 J
 (3) 0.4 J (4) 0.8 J
- In order to increase the sensitivity of a moving coil galvanometer, one should decrease
 (1) The strength of its magnet
 (2) The torsional constant of its suspension
 (3) The number of turns in its coil
 (4) The area of its coil
- Current i is carried in a wire of length L . If the wire is turned into a circular coil, the maximum magnitude of torque in a given magnetic field B will be
 (1) $\frac{LiB^2}{2}$ (2) $\frac{Li^2B}{2}$ (3) $\frac{L^2iB}{4\pi}$ (4) $\frac{Li^2B}{4\pi}$
- A current carrying loop is placed in a uniform magnetic field in four different orientations, I, II, III & IV arrange them in the decreasing order of potential Energy

 (1) $I > III > II > IV$ (2) $I > II > III > IV$
 (3) $I > IV > II > III$ (4) $III > IV > I > II$
- A rigid circular loop of radius R and mass m lies in the x-y plane on a flat table and has a current i flowing in it. At this particular place the earth's magnetic field is $\vec{B} = B_x \hat{i} + B_z \hat{k}$. The value of i , so that the loop starts tilting is :-
 (1) $\frac{mg}{\pi R \sqrt{B_x^2 + B_z^2}}$ (2) $\frac{mg}{\pi R B_x}$
 (3) $\frac{mg}{\pi R B_z}$ (4) $\frac{mg}{\pi R \sqrt{B_x B_z}}$
- Surface charge density on a ring of radius a and width d is σ as shown in the figure. It rotates with frequency f about its own axis. Assume that the charge is only on outer surface. The magnetic field induction at centre is (Assume that $d \ll a$) :-

 (1) $\pi \mu_0 f \sigma d$ (2) $\mu_0 f \sigma d$
 (3) $2 \pi \mu_0 f \sigma d$ (4) $\frac{\pi^2}{2\mu_0} f \sigma d$

11. Two short bar magnets of magnetic moments 'M' each are arranged at the opposite corners of a square of side 'd', such that their centres coincide with the corners and their axes are parallel to one side of the square. If the like poles are in the same direction, the magnetic induction at any of the other corners of the square is :-
 (1) $\frac{\mu_0 M}{4\pi d^3}$ (2) $\frac{\mu_0 2M}{4\pi d^3}$ (3) $\frac{\mu_0 M}{2\pi d^3}$ (4) $\frac{\mu_0 2M}{2\pi d^3}$
12. A bar magnet of magnetic moment 2 Am^2 is free to rotate about a vertical axis passing through its centre. If magnet is released from rest in east west position, then kinetic energy of magnet as it takes north-south position is (horizontal component of earth's magnetic field is $25 \mu\text{T}$):-
 (1) $125 \mu\text{J}$ (2) $200 \mu\text{J}$ (3) $25 \mu\text{J}$ (4) $50 \mu\text{J}$
13. At a place horizontal and vertical components of earth's magnetic field are as follows
 $B_H = 1 \text{ G}$ 10° west of north
 $B_V = 1 \text{ G}$ vertically downward
 Then dip angle and declination are respectively :-
 (1) 0° , 10° W (2) 45° , 10° E
 (3) 45° , 10° W (4) 10° W , 45°
14. If declination at a place is known to be 15° E . and a compass needle points as shown, then geographic north is represented by the direction numbered :-



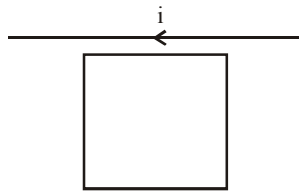
15. A magnetising field of 1600 Am^{-1} produces a magnetic flux 2.4×10^{-5} weber in an iron bar of cross-sectional area 0.2 cm^2 . The susceptibility of the iron bar will be :-
 (1) 1788 (2) 1192 (3) 596 (4) 298
16. Magnetostatic screening or shielding can be created by :-
 (1) Super conductor (2) Soft iron ring
 (3) Both (1) & (2) (4) Neither (1) nor (2)
17. The angle of dip on a given meridian, making an angle 30° with the magnetic meridian is equal to 30° . The true angle of dip at the given point is :-
 (1) $\tan^{-1}\left(\frac{1}{2}\right)$ (2) $\tan^{-1}(2)$
 (3) $\tan^{-1}(\sqrt{2})$ (4) $\tan^{-1}\left(\frac{1}{\sqrt{2}}\right)$
18. If angle of dip on two perpendicular meridians are 30° and 45° , then the true angle of dip is (none of the given meridians coincide with magnetic meridian)
 (1) $\tan^{-1}\frac{1}{2}$ (2) $\tan^{-1} 2$
 (3) $\tan^{-1}\sqrt{2}$ (4) $\tan^{-1}\frac{1}{\sqrt{2}}$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	1	4	2	3	1	2	3	3	2	1	1	4	3	2	3
Que.	16	17	18												
Ans	3	1	1												

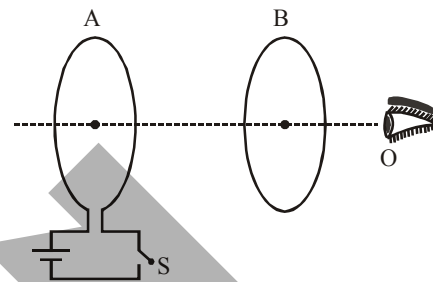
ELECTROMAGNETIC INDUCTION

1. Current i flows through a long wire. A square loop made of conducting wire held below the wire in the same vertical plane is released and allowed to fall under gravity. If acceleration of the loop is a , then :-



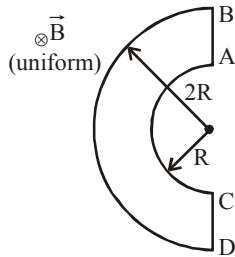
- (1) A current is induced in anticlockwise direction and $a > g$
 (2) A current is induced in the clockwise direction and $a < g$
 (3) A current is induced in anticlockwise direction and $a < g$
 (4) No current is induced in the loop and $a = g$
2. A conducting ring of radius r is placed perpendicularly inside a time varying magnetic field given by $B = B_0 + \alpha t$. B_0 and α are positive constants, E.m.f. induced in the ring is :-
- (1) $-\pi\alpha r$ (2) $-\pi\alpha r^2$
 (3) $-\pi\alpha^2 r^2$ (4) $-\pi\alpha^2 r$
3. Two different loops are concentric and lie in the same plane. The current in outer loop is clockwise and increasing with time. The induced current in the inner loop is :-
- (1) Clockwise
 (2) Zero
 (3) Anticlockwise
 (4) In a direction that depends on the ratio of the loop radii

4. As shown in figure, A and B are two coaxial conducting loops separated by some distance when the switch S is closed, a clockwise current I flows in A (as seen by O) and an induced current I_1 flows in B. The switch remains closed for a long time. When S is opened, a current I_2 flows in B. Then the direction of I_1 and I_2 (as seen by O) are:



- (1) Respectively clockwise and anticlockwise
 (2) Both clockwise
 (3) Both anticlockwise
 (4) Respectively anticlockwise and clockwise
5. If the rotational velocity of dynamo armature is four times, then the induced emf of the dynamo will be :-
- (1) Four times (2) Eight times
 (3) Half (4) None of these
6. A current of 1A and frequency n_1 is passed through a coil subsequently the frequency is made n_2 . If ϵ_1 and ϵ_2 be the induced peak emf in the coil, in the two cases then $\frac{\epsilon_1}{\epsilon_2}$ will be equal to :-
- (1) $n_2^2 : n_1^2$ (2) $n_1^2 : n_2^2$
 (3) $n_1 : n_2$ (4) $n_2 : n_1$
7. A uniform magnetic field exists in the region given by $\vec{B} = 3\hat{i} + 4\hat{j} + 5\hat{k}$. A rod of length 5 m placed along y-axis is moved along x-axis with constant speed 1 ms^{-1} . Then induced e.m.f in the rod is :-
- (1) Zero (2) 25 V
 (3) 5 V (4) 10 V

8. If given arrangement is moving towards left with speed v , then potential difference between B and D and current in the loop are respectively :-



- (1) BvR and non-zero (2) $2BvR$ and zero
(3) $4BvR$ and non-zero (4) $4BvR$ and zero
9. A semicircular loop of radius R is rotated with an angular velocity ω perpendicular to the plane of a uniform magnetic field B as shown in the figure. Emf induced in the loop is :
- (1) $B\omega R^2$
(2) $\frac{1}{2} B\omega R^2$
(3) $\frac{3}{2} B\omega R^2$
(4) $\frac{1}{4} B\omega R^2$
10. An inductance of $2H$ carries a current of $2A$. To prevent sparking when the circuit is broken, a capacitor of $4\mu F$ is connected across the inductance. The voltage rating of the capacitor is of the order of :
- (1) $1000 V$ (2) $10 V$ (3) $100 V$ (4) $10^4 V$
11. Two coils have self inductance $L_1 = 4mH$ and $L_2 = 1 mH$ respectively. The currents in the two coils are increased at the same rate. At a certain instant of time both coils are given the same power. If I_1 and I_2 are the currents in the two coils, at that instant of time respectively, then

the value of $\left(\frac{I_1}{I_2}\right)$ is :-

- (1) $\frac{1}{8}$ (2) $\frac{1}{4}$ (3) $\frac{1}{2}$ (4) 1

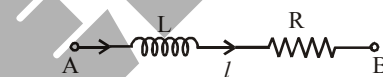
12. Two coils having self inductance $2H$ and $8H$ have a mutual inductance of $3H$. Find the coefficient of coupling.

- (1) $3/4$ (2) $1/2$ (3) $8/3$ (4) $4/3$

13. A conducting ring of radius b is placed coaxially in a long solenoid of radius a ($b < a$) having n turns per unit length. A current $i = i_0 \cos \omega t$ flows through the solenoid. The induced emf in the ring is :-

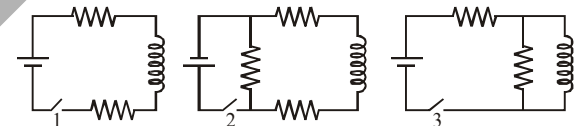
- (1) Zero (2) $\mu_0 n i_0 \pi a^2 \omega$
(3) $\mu_0 n i_0 \pi a^2 \cos \omega t$ (4) $\mu_0 n i_0 \pi b^2 \omega \sin \omega t$

14. In an A.C. sub-circuit as shown in figure, the resistance $R = 0.2 \Omega$. At a certain instant $V_A - V_B = 0.5 V$, $I = 0.5 A$, and current is increasing at the rate of $\frac{\Delta I}{\Delta t} = 8 A/s$. The inductance of the coil is



- (1) $0.01 H$ (2) $0.02 H$
(3) $0.05 H$ (4) $0.5 H$

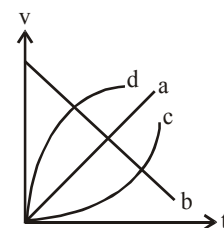
- 15.



The figure shows three circuits with identical batteries, inductors and resistances. Rank the circuits according to the currents through the battery just after the switch is closed, greatest first.

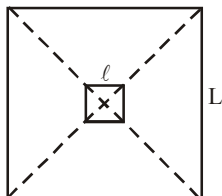
- (1) $I_2 > I_3 > I_1$ (2) $I_2 > I_1 > I_3$
(3) $I_1 > I_2 > I_3$ (4) $I_1 > I_3 > I_2$

16. A bar magnet is made to fall through a long vertical copper tube. The speed (v) of the magnet as a function of time (t) is best represented by :-



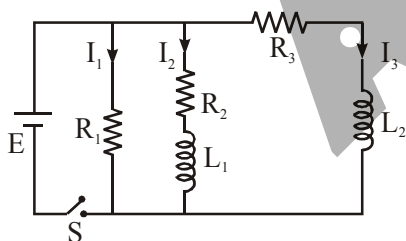
- (1) a (2) b (3) c (4) d

17. A small square loop of wire of side l is placed inside a large square loop of wire of side L ($\gg l$). The loops are coplanar and their centres coincide. The mutual inductance of the system is :



- (1) $\frac{2\sqrt{2}\mu_0 L}{\pi l}$
 (2) $\frac{2\sqrt{2}\mu_0 L^2}{\pi l}$
 (3) $\frac{2\sqrt{2}\mu_0 l}{\pi L}$
 (4) $\frac{2\sqrt{2}\mu_0 l^2}{\pi L}$

18. Figure shows an L-R circuit. When the switch S is closed, the current through resistor R_1 , R_2 and R_3 are I_1 , I_2 and I_3 respectively. The value of I_1 , I_2 and I_3 at $t = 0$ s is :



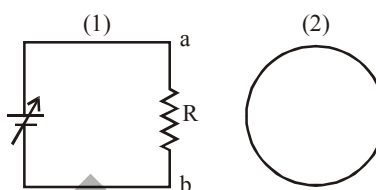
- (1) $I_1 = I_2 = I_3 = 0$
 (2) $I_1 = \frac{E}{R_1}$, $I_2 = I_3 = 0$
 (3) $I_1 = 0$, $I_2 = \frac{E}{R_2}$, $I_3 = \frac{E}{R_3}$
 (4) $I_1 = \frac{E}{R_1}$, $I_2 = \frac{E}{R_2 + L_1}$, $I_3 = \frac{E}{R_3 + L_3}$

19. If magnetic field passing through a coil of area 0.1 m^2 is changing according to the equation

$$B = 10 \sin\left(\frac{2\pi t}{3}\right) \text{ tesla. Find the magnitude of}$$

induced emf at $t = 0.5 \text{ s}$

20. The emf of the battery in loop-(1) is increased. Find the direction of induced current in the loop-(2).



21. In LR circuit the current increases to one fourth of its maximum value in 4 sec then the time constant of circuit is :-

- (1) $2 \log_e 2$ (2) $\frac{4}{\log_e 2}$
 (3) $\frac{4}{\log_e (4/3)}$ (4) $\frac{\log_e 2}{2}$

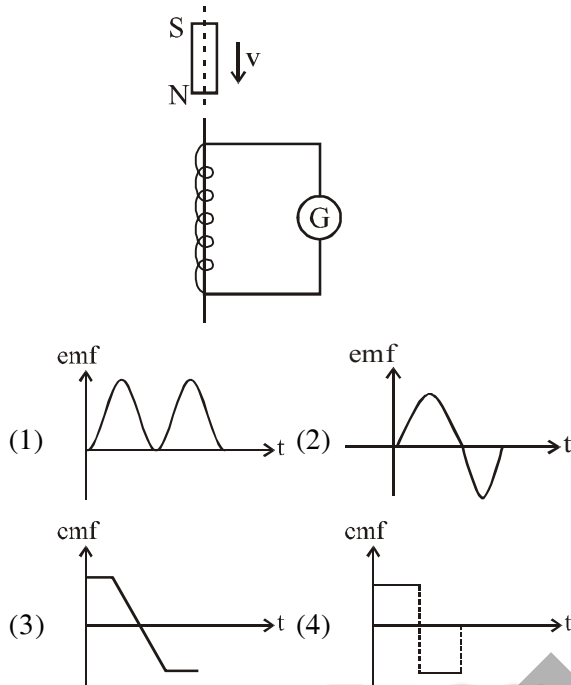
22. A small cube of volume 1 mm^3 placed at the centre of circular loop of radius of 100 cm , carrying a current 1 A . The magnetic energy stored in side cube is :-

- (1) $\frac{\pi}{2} \times 10^{16} \text{ J}$ (2) $2\pi \times 10^{-7} \text{ J}$
 (3) $\frac{\pi}{2} \times 10^{-16} \text{ J}$ (4) $\frac{\pi}{2} \times 10^{-7} \text{ J}$

23. Flux through a coil of 4Ω resistance is $\phi = (2t^2 + 9) \text{ wb}$. The induced heat in coil in first 3 sec. :-

- (1) 12 J (2) 4 J
 (3) 36 J (4) 1.2 J

24. A bar magnet released from rest in the effect of gravity along vertical axis of coil then which of the following variation is correct regarding induced emf with respect to time when it passes through the coil :-



ANSWERS

1. 3 2. 2 3. 3 4. 4 5. 1 6. 3 7. 2 8. 4 9. 2 10. 1 11. 2 12. 1 13. 4 14. 3
 15. 1 16. 4 17. 4 18. 2 19. $\frac{\pi}{3}$ volt 20. Clockwise 21. 3 22. 3 23. 3 24. 2

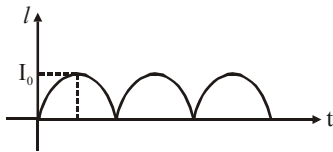
ALTERNATING CURRENT

RACE # 01

1. The voltage supplied to a circuit is given by $V = V_0 t^{3/2}$, where t is time in second. Find the RMS value of voltage for the period $t = 0$ to $t = 1$ s :-

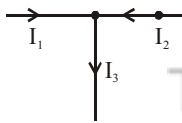
(1) $\frac{V_0}{2}$ (2) V_0 (3) $\frac{3V_0}{2}$ (4) $2V_0$

2. The output current versus time curve for a rectifier is shown in the figure. The average value of output current in this case is :-



(1) 0 (2) $\frac{I_0}{2}$ (3) $\frac{2I_0}{\pi}$ (4) I_0

3. If current $I_1 = 3A \sin \omega t$ and $I_2 = 4A \cos \omega t$, then I_3 is :-



(1) $5A \sin(\omega t + 53^\circ)$ (2) $5A \sin(\omega t + 37^\circ)$
(3) $5A \sin(\omega t + 45^\circ)$ (4) $5A \sin(\omega t + 30^\circ)$

4. What is the approximate peak value of an alternating current producing four times the heat produced per second by a steady current of 2 A in a resistor :-

(1) 2.8 A (2) 4.0 A (3) 5.7 A (4) 8.0 A

5. If instantaneous current in a circuit is given by $I = (2 + 3 \sin \omega t)A$, then the effective value of resulting current in the circuit is :-

(1) $\sqrt{\frac{17}{2}}A$ (2) $\sqrt{\frac{2}{17}}A$

(3) $\sqrt{\frac{3}{2}}A$ (4) $3\sqrt{2}A$

6. An electric lamp marked 100 volt d.c. consumes a current of 10A. If it is connected to a 200 volt, 50 Hz AC mains. Calculate the inductance of choke (inductor coil) required :-

(1) $5.5 \times 10^{-2} H$ (2) $5.5 \times 10^{-1} H$
(3) 11.0 H (4) $11.0 \times 10^{-2} H$

7. A long solenoid connected to a 12 volt DC source passes a steady current of 2A. When the solenoid is connected to an AC source of 12 volt at 50 Hz, the current flowing is 1A. Calculate inductance of the solenoid :-

(1) 33 mH (2) 66 mH
(3) 16.5 mH (4) 40 mH

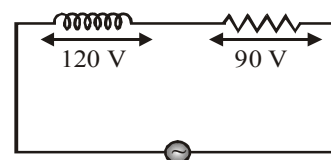
8. When an electric device X is connected to a 220 volt, 50 hertz a.c. supply, the current is 0.5 A, and is in same phase as the applied voltage. When another device Y is connected to the same supply, the electric current is again 0.5

A, but it leads the potential difference by $\frac{\pi}{2}$.

When X and Y are connected in series across the same source, what will be the current ?

(1) 0.35 A
(2) 0.55 A
(3) 1.35 A
(4) 2.5 A

9. If current in the circuit is 3A, then impedance of the circuit shown in the figure is :-

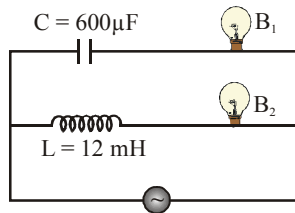


(1) 100 Ω (2) 50 Ω
(3) 30 Ω (4) 40 Ω

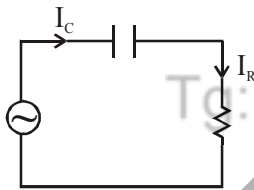
10. A direct current of 10 A is superimposed on an alternating current $i = 40 \cos \omega t(A)$ flowing through a wire. The effective value of the resulting current will be :-

(1) $10\sqrt{2} A$
(2) $20\sqrt{2} A$
(3) $20\sqrt{3} A$
(4) 30 A

11. In the circuit shown in figure, if both the bulbs B_1 and B_2 identical then :-



- (1) Both bulbs have equal brightness
(2) B_2 will be brighter than B_1
(3) At very high frequency of source brightness of B_1 is more than B_2 .
(4) At the very low frequency of source the brightness of B_1 is more than B_2 .
12. Given figure shows a source of alternating voltage connected to a capacitor and a resistor. Which of the following phasor diagrams correctly describes the phase relationship between I_C , the current between the source and the capacitor and I_R , the current in resistor ?



- (1) I_R and I_C are in phase (represented by two parallel horizontal vectors).
(2) I_C leads I_R (represented by I_C vector ahead of I_R vector).
(3) I_R leads I_C (represented by I_R vector ahead of I_C vector).
(4) I_C and I_R are out of phase (represented by two vectors at an angle).

13. An AC voltage is represented by

$$E = 575 \sqrt{5} \cos(75\pi)t$$

How many times will the current become zero in 1 second ?

- (1) 75 times
(2) 50 times
(3) 100 times
(4) 575 times

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	
Ans	1	3	1	3	1	1	1	1	2	4	3	1	1	

ALTERNATING CURRENT

RACE # 02

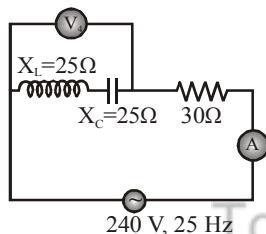
1. In an LCR series circuit, the potential difference between the terminals of the inductance is 60 V, between the terminals of the capacitor is 30 V and across the resistance is 40V. Then supply voltage will be equal to :-

(1) 50 V (2) 70 V
(3) 130 V (4) 10 V

2. In an LCR series circuit, the voltage across each of the components, L, C and R is 50 V. Then voltage across the L-C combination will be :-

(1) 50 V (2) Zero
(3) $50\sqrt{2}$ V (4) 100 V

3. In the circuit shown in figure neglecting source resistance, the voltmeter and ammeter reading will respectively be :-

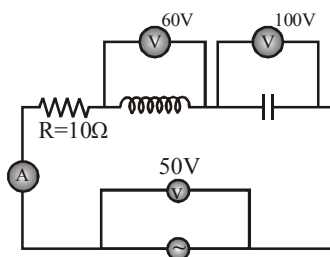


(1) 0 V, 3 A (2) 150 V, 3 A
(3) 150 V, 6 A (4) 0 V, 8 A

4. In a series LCR circuit which is connected to an AC voltage source, choose the incorrect statement :-

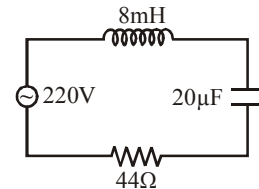
(1) Algebraic sum of instantaneous voltage across L, C, R is a variable
(2) $V_{L_{inst}} + V_{C_{inst}} + V_{R_{inst}} = V_{Source_{inst}}$
(3) $V_{L_{inst}} + V_{C_{inst}} + V_{R_{inst}} = V_{Source_{rms}}$
(4) Current through inductor, capacitor and resistance is same

5. In the circuit shown in figure the current measured by ammeter is :-



(1) 1 A (2) 2 A (3) 3 A (4) Zero

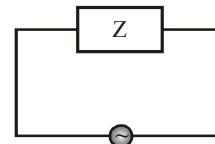
6. For the series LCR circuit shown in the figure, what is the resonance frequency and the amplitude of the current at the resonating frequency :-



(1) 2500 rad s⁻¹ and $5\sqrt{2}$ A
(2) 2500 rad s⁻¹ and 5A
(3) 2500 rad s⁻¹ and $\frac{5}{\sqrt{2}}$ A
(4) 25 rad s⁻¹ and $5\sqrt{2}$ A

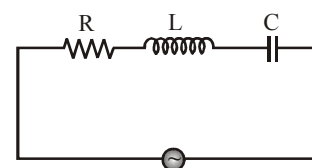
7. In a box Z of unknown elements, L or R or any other combination, an ac voltage $E = E_0 \sin(\omega t + \phi)$ is applied and current in the circuit was found to

be $I = I_0 \sin\left(\omega t + \phi + \frac{\pi}{4}\right)$. The unknown element in the box may be :-



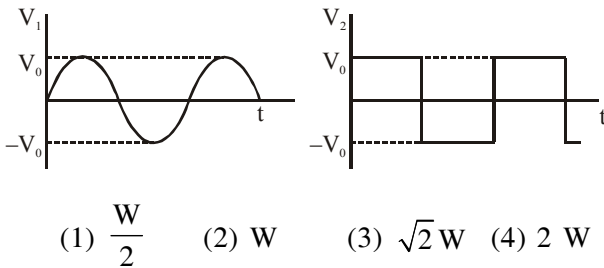
(1) Only capacitor
(2) inductor and resistor both
(3) Either capacitor, resistor and inductor or only capacitor and resistor
(4) Only resistor

8. In the following circuit the emf of source is $E_0 = 200$ volt, $R = 20\Omega$, $L = 0.1$ henry, $C = 10.6$ farad and frequency is variable then the current at frequency $f = 0$ and $f = \infty$ is :-

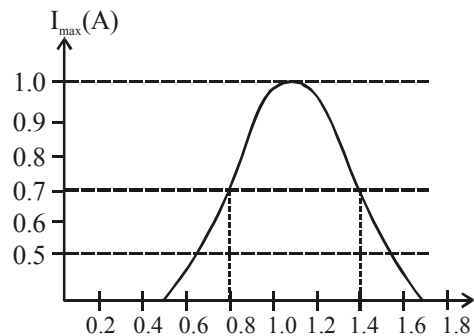


(1) Zero, 10 A (2) 10 A, zero
(3) 10 A, 10 A (4) Zero, zero

9. With increase in frequency of an a.c. supply, the impedance of an LCR series circuit :-
 (1) Remains constant
 (2) Decreases
 (3) Increases
 (4) Decreases at first, becomes minimum and then increases
10. The sinusoidal potential difference V_1 shown in figure applied across a resistor R produces heat at a rate W . What is the rate of heat dissipation when the square wave potential difference V_2 as shown in figure is applied across the resistor :-



11. For series L-C-R circuit the plot of $I_{\max}$ versus ω is shown in the figure. The bandwidth will be:



- (1) 0.2 rad s^{-1} (2) 0.3 rad/sec
 (3) 0.6 rad/sec (4) 0.5 rad/sec
12. For a series L-C-R circuit, the voltage across resistance, capacitance and inductance is 10 V each. If the capacitance is short circuited, the voltage across the inductance will be :-
- (1) 10 V (2) $\frac{10}{\sqrt{2}} \text{ V}$ (3) $\frac{10}{3} \text{ V}$ (4) 20 V

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	
Ans	1	2	4	3	3	1	3	4	4	4	3	2	

EM WAVE

- An electromagnetic wave going through vacuum is described by $E = E_0 \sin(\omega t - kx)$, $B = B_0 \sin(\omega t - kx)$ then
 (1) $E_0 K = B_0 \omega$ (2) $E_0 B_0 = \omega L$
 (3) $E_0 \omega = B_0 K$ (4) $B_0 = \frac{E_0}{K}$
- A free proton is placed in the path of a plane electromagnetic wave. The proton will start moving :-
 (1) In the direction of propagation of EM wave
 (2) Along the magnetic field
 (3) Along the electric field
 (4) In the plane containing the magnetic field and the direction of propagation
- Displacement current goes through the gap between the plates of a capacitor when the charge of the capacitor :-
 (a) does not change (b) change with time
 (c) increases (d) decreases
 (1) (a), (c) and (d) (2) (a), (b) and (d)
 (3) (b), (c) and (d) (4) (a), (b) and (c)
- Energy of electromagnetic wave is due to their:-
 (1) Electric field only
 (2) Magnetic field only
 (3) Electric field, magnetic field and energy equal distributed in both field
 (4) Electric field, magnetic field and energy not equal distributed in both field
- An L-C resonant circuit contains a 400 pF capacitor and a 100 μ H inductor. It is set into oscillation coupled to an antenna. The wavelength of the radiated electromagnetic waves is :-
 (1) 377 mm (2) 377 m
 (3) 377 cm (4) 3.77 cm
- Which of the following statements is incorrect about electromagnetic waves ?
 (1) Are transverse in nature
 (2) Are produced by accelerating charges
 (3) Travel with the same speed in all media
 (4) Travel in free space with the speed of light
- In electromagnetic wave the phase difference between electric and magnetic field vectors $\vec{E}$ and $\vec{B}$ is :-
 (1) zero (2) $\pi/2$ (3) π (4) $\pi/4$
- Electromagnetic waves are produced by :-
 (1) charges at rest only
 (2) charges in uniform motion only
 (3) accelerated or decelerated charges
 (4) all of the above
- Total energy of electromagnetic waves in vacuum is given by the relation :-
 (1) $\frac{1}{2} \cdot \frac{E^2}{\epsilon_0} + \frac{B^2}{2\mu_0}$
 (2) $\frac{1}{2} \epsilon_0 E^2 + \frac{1}{2} \mu_0 B^2$
 (3) $\frac{E^2 + B^2}{c}$
 (4) $\frac{1}{2} \epsilon_0 E^2 + \frac{B^2}{2\mu_0}$
- In free space an electromagnetic wave that propagates in the +z direction with an electric field strength of 1 V/m pointing in the +y direction. Then the direction and magnitude of the magnetic field is :-
 (1) 3.33×10^{-9} T in (-y) direction
 (2) 3.33×10^{-9} T in (-x) direction
 (3) 3.33×10^{-9} T in (+x) direction
 (4) 9.99×10^{-7} T in (-x) direction

11. If electric field in a non-magnetic medium for EM wave is given by $\vec{E} = 100\sin(10^8t + 2z)\hat{j}$ V/m then $\vec{H}$ is (in S.I.) :-

- (1) $\frac{50}{\pi}\sin(10^8t + 2z)\hat{i}$ (2) $\frac{5}{\pi}\sin(10^8t + 2z)\hat{i}$
 (3) $20\sin(10^8t + 2z)\hat{j}$ (4) $\frac{25}{\pi}\sin(10^8t + 2z)\hat{j}$

12. The velocity of electromagnetic wave is parallel to :-

- (1) $\vec{B} \times \vec{E}$ (2) $\vec{E} \times \vec{B}$ (3) $\vec{E}$ (4) $\vec{B}$

13. Electromagnetic wave of intensity 1400 W/m^2 falls normally on a surface of area 1.5 m^2 is completely absorbed by it. Find out force exerted by beam.

- (1) $14 \times 10^{-5} \text{ N}$ (2) $14 \times 10^{-6} \text{ N}$
 (3) $7 \times 10^{-5} \text{ N}$ (4) $7 \times 10^{-6} \text{ N}$

Tg: @Chalnaayaaar

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	
Ans	1	3	3	3	2	3	1	3	4	2	2	2	4	

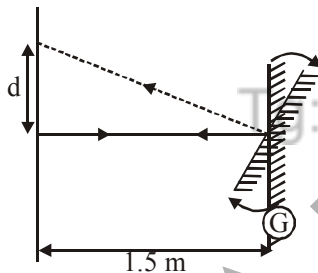
RAY OPTICS (PLANE MIRROR)

RACE # 01

1. A plane mirror is moving with velocity $4\hat{i} + 5\hat{j} + 8\hat{k}$. A point object in front of the mirror moves with a velocity $3\hat{i} + 4\hat{j} + 5\hat{k}$. Here $\hat{i}$ is along the normal to the plane mirror and facing towards the object. The velocity of the image is:-

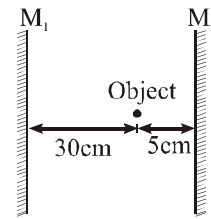
- (1) $5\hat{i} + 4\hat{j} + 5\hat{k}$ (2) $5\hat{i} + 4\hat{j} + 8\hat{k}$
(3) $3\hat{i} + 4\hat{j} + 5\hat{k}$ (4) $6\hat{i} + 4\hat{j} + 5\hat{k}$

2. Light incident normally on a plane mirror attached to a galvanometer coil retraces backwards as shown in figure. A current in the coil produces a deflection of 3.5° of the mirror. What is the displacement of reflected spot of light on a screen placed 1.5 m away ?



- (1) 10.5 cm (2) 18.31 cm
(3) 15 cm (4) 3 cm

3.



Position of 5th image of given object in mirror M_2 is :-

- (1) 65 cm from mirror M_2
(2) 145 cm from mirror M_2
(3) 170 cm from mirror M_2
(4) 135 cm from mirror M_2

4. Two plane mirrors are kept at an angle α . A light ray striking the two mirrors successively suffers a deviation of $5\pi/6$ in two reflection. The value of α is:-

- (1) $\pi/9$ (2) $\frac{7\pi}{12}$ (3) $\frac{3\pi}{5}$ (4) $\frac{9\pi}{11}$

5. A point object approaches a plane mirror with a speed of 10 ms^{-1} , while the image recedes away from the mirror with a speed of 6 ms^{-1} . The direction and magnitude of the velocity of mirror is :-

- (1) towards the object, 8 ms^{-1}
(2) towards the image, 6 ms^{-1}
(3) away from the object, 8 ms^{-1}
(4) away from the object, 2 ms^{-1}

6. A person is in a room whose ceiling and two adjacent walls are mirrors. How many images are formed :-

- (1) 5 (2) 6 (3) 7 (4) 8

ANSWER KEY

Que.	1	2	3	4	5	6
Ans	1	2	2	2	3	3

RAY OPTICS (SPHERICAL MIRROR)

RACE # 02

- The focal length of a concave mirror is 50cm. Where an object be placed so that its image is two times magnified and inverted :-
(1) 75 cm (2) 72 cm
(3) 63 cm (4) 50 cm
- A concave mirror gives an image three times as large the object placed at a distance of 20 cm from it. For the image to be real, the focal length should be :-
(1) 10 cm (2) 15 cm
(3) 20 cm (4) 30 cm
- An object is placed at 20 cm from a convex mirror of focal length 10 cm. The image formed by the mirror is :-
(1) Real and at 10 cm from the mirror
(2) Virtual and at 10 cm from the mirror
(3) Virtual and at $20/3$ cm from the mirror
(4) Real and at $20/3$ cm from the mirror
- An object 2.5 cm high is placed at a distance of 10 cm from a concave mirror of radius of curvature 30 cm the size of the image is :-
(1) 9.2 cm (2) 10.5 cm
(3) 5.6 cm (4) 7.5 cm
- A small candle 2.5 cm in size is placed 27 cm in front of a concave mirror of radius of curvature 36 cm. At what distance from the mirror should a screen be placed in order to receive a sharp image. What is size of image :- [NCERT]
(1) 54, 5
(2) 54, 10
(3) 30, 5
(4) 30, 10
- A 4.5 cm needle is placed 12 cm away from a convex mirror of focal length 15 cm. Find the location of the image and the magnification. [NCERT]

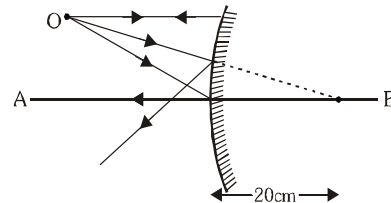
(1) 5.5cm, $\frac{2}{3}$

(2) 6.7cm, $\frac{5}{9}$

(3) 5.5cm, $\frac{5}{9}$

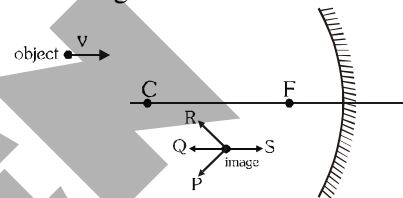
(4) 6.7cm, $\frac{2}{3}$

- In the figure a convex mirror of radius of curvature 20 cm is shown. An object O is placed in front of this mirror. Its ray diagram is shown. How many mistakes are there in the diagram? (AB is its principal axis)



- (1) 3 (2) 2 (3) 1 (4) 0

- In the diagram shown the velocity of image will be along

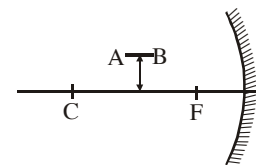


- (1) P (2) Q (3) R (4) S

- Select the incorrect statement from the following

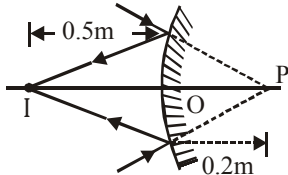
- For concave mirror, if image of real object is virtual then magnification must be positive
- A virtual image cannot be displayed on the screen
- Aberration occur only for real images
- Chromatic aberration does not occur with mirrors

- An object AB is placed parallel and close to the optical axis between focus F and centre of curvature C of a converging mirror of focal length f as shown in figure.



- Image of B will be closer than that of A from the mirror.
- Image of AB will be parallel to the optical axis.
- Length of image is equal to AB.
- Length of image is more than AB.

11. A beam of convergent light converges to a point 0.5 m in front of the mirror after reflection at a convex mirror but in the absence of the mirror the beam converges to a point 0.2 m behind the mirror. The radius of curvature of the mirror is :-



- (1) 20 cm (2) 50 cm
 (3) 66.67 cm (4) 28.57 cm

12. The distance of an object from a spherical mirror is equal to the focal length of the mirror then the image :-

- (1) must be at infinity
 (2) may be at infinity
 (3) may be at the focus
 (4) none

13. A point object is placed 60 cm from pole of a concave mirror of focal length 10 cm on the principal axis. If object is shifted 1 mm towards the mirror along principal axis. Find the shift in image ?

- (1) $\frac{1}{25}$ mm (2) $\frac{1}{50}$ mm
 (3) $\frac{1}{100}$ mm (4) $\frac{1}{125}$ mm

ANSWER KEY

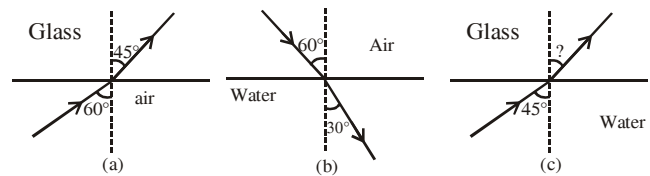
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	
Ans	1	2	3	4	1	2	1	1	3	4	3	2	1	

RAY OPTICS (REFRACTION & TOTAL INTERNAL REFLECTION) RACE # 03

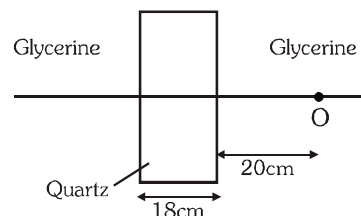
- To an observer on the earth, the stars appear to twinkle. This can be described to :-
 (1) The fact that stars do not emit light continuously
 (2) Frequency absorption of star light by their own atmosphere
 (3) Frequency absorption of star light by the earth's atmosphere
 (4) The refractive index fluctuations in the earth's atmosphere
- To a fish in water, a bird in air appears to be at 30 cm from the surface. If $\mu_w = \frac{4}{3}$, then the true distance of the bird from the surface is :-
 (1) 40 cm (2) 22.5 cm
 (3) 80 cm (4) None of the above
- A transparent cube of 15 cm edge contains a small air bubble. Its apparent depth when viewed through one face is 6 cm and when viewed through opposite face is 4 cm. The refractive index of material of cube is :-
 (1) 2.0 (2) 1.5
 (3) 1.6 (4) 2.5
- What is the time taken (in seconds), to cross a glass of thickness 4 mm and $\mu = 3$, by light ?
 (1) 4×10^{-11} (2) 2×10^{-11}
 (3) 16×10^{-11} (4) 8×10^{-10}
- A small pin fixed on a table top is viewed from above from a distance of 50 cm. by what distance would the pin appear to be raised if it is viewed from the same point through a 15 cm thick glass slab held parallel to the table ? [NCERT]
 ($\mu_{\text{glass}} = 1.5$)
 (1) 10 cm (2) 25 cm
 (3) 5 cm (4) None of these
- The speeds of light in two media I and II are 2.2×10^8 m/s and 2.4×10^8 m/s respectively. The critical angle for light refracting from I to II medium will be :-

- $\sin^{-1} \frac{12}{11}$ (2) $\sin^{-1} \frac{11}{12}$
- $\sin^{-1} \frac{21}{24}$ (4) $\sin^{-1} \frac{24}{21}$

- Figure (a) and (b) show refraction of a ray in air incident at 60° with the normal to a glass air and water air interface, respectively. What is the angle of refraction in glass when the angle of incidence in water is 45° with the normal to a water-glass interface figure (c):-
 [NCERT]

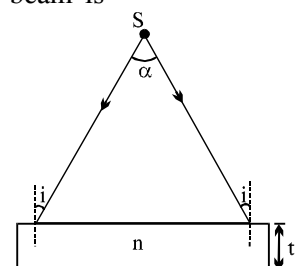


- (1) 38° (2) 60°
 (3) 90° (4) 52°
- Given that, velocity of light in quartz is 1.5×10^8 m/s and velocity of light in glycerine is $\frac{9}{4} \times 10^8$ m/s. Now a slab made of quartz is placed in glycerine as shown. What is the shift produced by slab, if seen from other side of slab.



- (1) 6 cm (2) 3.55 cm
 (3) 9 cm (4) 2 cm
- A diverging beam of light from a point source S having divergence angle α , falls symmetrically on a glass slab as shown. The angles of incidence of the two extreme rays are equal. If the thickness of the glass slab is t and the refractive index n , then the divergence angle of the emergent beam is

- (1) zero
- (2) α
- (3) $\sin^{-1}(1/n)$
- (4) $2\sin^{-1}(1/n)$

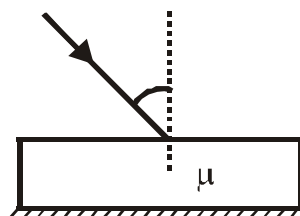


10. How much water would be filled in a container of height 21 cm, so that it appears half filled to the observer when viewed from the top of the container ? ($\mu_w = 4/3$)

- (1) 8 cm (2) 10.5 cm
(3) 12 cm (4) 14 cm

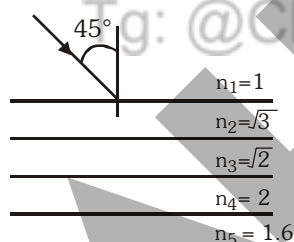
11. One side of a glass slab is silvered as shown. A ray of light is incident on the other side at angle of incidence $i = 45^\circ$. Refractive index of glass is given as 1.5. The deviation of the ray of light from its initial path when it comes out of the slab is

- (1) 90°
(2) 180°
(3) 120°
(4) 45°

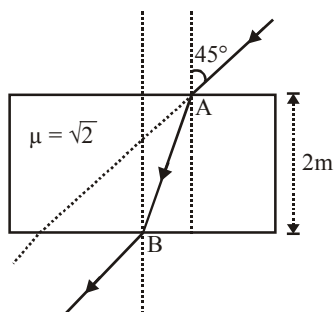


12. In the figure shown the angle made by the light ray with the normal in the medium of refractive index $\sqrt{2}$ is:

- (1) 30°
(2) 60°
(3) 90°
(4) None of these



13. Find the time taken by a monochromatic light to cross a transparent slab of width 2m and R.I. = $\sqrt{2}$ as shown in figure :

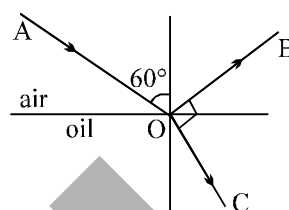


- (1) $\frac{2\sqrt{2}}{3} \times 10^{-8} \text{ s}$ (2) $\frac{4\sqrt{2}}{3} \times 10^{-8} \text{ s}$
(3) $\frac{4}{3\sqrt{3}} \times 10^{-8} \text{ s}$ (4) $\frac{4\sqrt{2}}{3\sqrt{3}} \times 10^{-8} \text{ s}$

14. A ray of light is incident from a rarer medium ($\mu = 1.5$) into a denser medium. If the angle of incidence and refraction are respectively 60° and 45° , then calculate the refractive index of the denser medium.

- (1) 1 (2) 1.73 (3) 1.5 (4) 1.84

15. A ray of light AO is incident on the surface of oil. Reflected part of this ray OB and refracted part OC are mutually perpendicular as shown. Find refractive index of oil.



- (1) $\sqrt{3}$ (2) $\frac{2}{\sqrt{3}}$ (3) $\frac{1}{\sqrt{3}}$ (4) 2

16. A ray of light travelling inside a rectangular glass block of refractive index $\sqrt{2}$ is incident on the glass-air surface at an angle of incidence of 45° . The refractive index of air is one. Under these conditions, the ray :-

- (1) Will emerge into the air without any deviation
(2) Will be reflected back into the glass
(3) Will be absorbed
(4) Will emerge into the air with an angle of refraction equal to 90°

17. If the refractive index of water is $\frac{4}{3}$ and that of glass slab is $\frac{5}{3}$, then the critical angle of incidence for which a light ray tending to go from glass to water is totally reflected is :-

- (1) $\sin^{-1} \frac{3}{4}$ (2) $\sin^{-1} \frac{3}{5}$
(3) $\sin^{-1} \frac{2}{3}$ (4) $\sin^{-1} \frac{4}{5}$

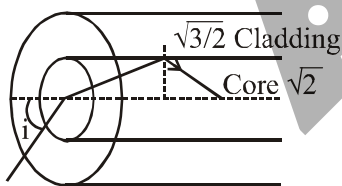
18. With respect to air, critical angle in a medium for light of red colour [λ_1] is θ . Other facts remaining same, critical angle for light of yellow colour [λ_2] will be :-

- (1) θ
(2) More than θ
(3) Less than θ
(4) $\frac{\theta\lambda_1}{\lambda_2}$

19. A small bulb is placed at the bottom of a tank containing water to a depth of 80 cm. What is the area of the surface of water through which light from the bulb can emerge out :- [NCERT]

- ($\mu_{\text{water}} = 1.33$)
(1) 2.54 m^2
(2) 3.71 m^2
(3) 1.11 m^2
(4) 4 m^2

20. Figure shows a cross section of a 'light pipe' made of a glass fibre of refractive index $\sqrt{2}$. The outer covering of the pipe is made of a material of refractive index $\sqrt{\frac{3}{2}}$. What is maximum angle of the incident ray with the axis of the pipe for which total internal reflections inside the pipe take place:-

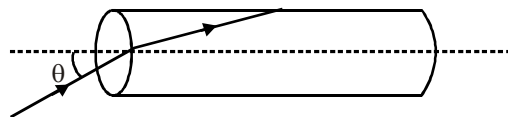


- (1) 45° (2) 66° (3) 80° (4) 90°

21. In the above problem, what is the answer if there is no outer covering of the pipe

- (1) 30° (2) 45°
(3) 90° (4) None of these

22. A transparent solid cylindrical rod has a refractive index of $2/\sqrt{3}$. It is surrounded by air. A light ray is incident at the midpoint of one end of the rod as shown in the figure.



The incident angle θ for which the light ray grazes along the wall of the rod is :

- (1) $\sin^{-1}(1/2)$ (2) $\sin^{-1}(\sqrt{2}/2)$
(3) $\sin^{-1}(2/\sqrt{3})$ (4) $\sin^{-1}(1/\sqrt{3})$

ANSWER KEY

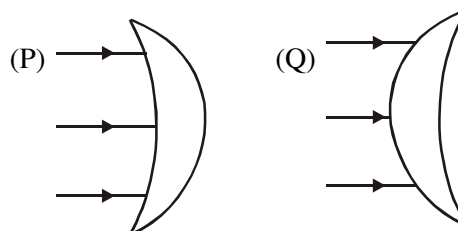
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	4	2	2	1	3	2	3	1	2	3	1	1	4	4	1
Que.	16	17	18	19	20	21	22								
Ans	4	4	3	1	1	3	4								

RAY OPTICS (Lenses)

RACE # 04

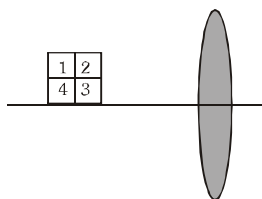
1. If the radius of curvature of the convex surface of a plano-convex lens is 18 cm and the refractive index of material of the lens is 1.6, the focal length of the lens is
(1) 18 cm (2) 24 cm (3) 30 cm (4) 40 cm
2. A converging lens of focal length 20 cm and made of a material with refractive index 1.1 is immersed in water. The lens will behave as a :-
(1) Convergent lens of focal length 20 cm
(2) Convergent lens of focal length lesser than 20 cm
(3) Divergent lens
(4) Plane glass plate
3. An object is located at 10 cm in front of a convex lens of focal length 12 cm. Find the position and nature of image :-
(1) 60 cm real
(2) 60 cm virtual
(3) 5.45 cm virtual
(4) 5.45 cm real
4. A diverging meniscus lens has a focal length of -20 cm. If the lens held 10 cm from the object, the magnification is :-
(1) -0.667 (2) +0.667
(3) -2 (4) +2
5. The radius of curvature of a thin plano-convex lens is 10 cm and the refractive index is 1.5. If the plane surface is silvered, then the focal length will be :-
(1) -20 cm (2) -10 cm
(3) 10 cm (4) 20 cm
6. A lamp is placed 6.0 m from a wall. On putting a lens between the lamp and the wall, at a distance of 1.2 m from the lamp, a real image of the lamp is formed on the wall. The magnification of the image is :-
(1) 3 (2) 4 (3) 5 (4) 6
7. An eye specialist prescribes spectacles having a combination of convex lens of focal length 40 cm in contact with a concave lens of focal length 25 cm. The power of this lens combination in dipotre is:-
(1) +1.5 D (2) -1.5 D
(3) +6.67 D (4) -6.67 D
8. A plano convex and another plano convex lens have the same focal length of 20 cm and are put in contact to form a lens combination. The combination is used to view an object of 0.5 cm length kept at 20 cm from the lens combination. As compared to the object, the image will be :-
(1) Magnified and inverted
(2) Reduced and erect
(3) Same size as the object and erect
(4) Same size as the object and inverted
9. A plano-convex lens of focal length 20 cm silvered at the plane surface will behave as a convergent mirror of focal length :-
(1) 20 cm (2) 30 cm (3) 40 cm (4) 10 cm
10. A concave lens of glass, refractive index 1.5, has both surfaces of same radius of curvature R. On immersion in a medium of refractive index 1.75, it will behave as a :-
(1) Convergent lens of focal length 3.5 R
(2) Convergent lens of focal length 3.0 R
(3) Divergent lens of focal length 3.5 R
(4) Divergent lens of focal length 3.0 R
11. A concave mirror and a convex lens both have same focal length in air. When they are submerged in glycerine, the focal length :-
(1) Of both still remains unchanged
(2) Of the mirror remains unchanged while that of the lens increases
(3) Of the mirror remains unchanged while that of the lens decreases
(4) Of both may increase or decrease

12. A convex lens of focal length f produces an image, μ times the size of the object; then the distance of the object from the lens is :-
(If the image is real)
- (1) $(\mu - 1)f$ (2) $(\mu + 1)f$
- (3) $\frac{(+\mu - 1)f}{\mu}$ (4) $\frac{(\mu + 1)f}{\mu}$
13. What is the refractive index of material of a plano-convex lens, if the radius of curvature of the convex surface is 10 cm and focal length of the lens is 30 cm ?
- (1) 1.33 (2) 1.5 (3) 1.1 (4) None
14. Two plano-concave lenses of glass of refractive index 1.5 have radii of curvature of 20 and 30 cm. They are placed in contact with curved surfaces towards each other and the space between them is filled with a liquid of refractive index $(4/3)$. Find the focal length of the system.
- (1) 60 cm (2) 72 cm
(3) 40 cm (4) 34 cm
15. Double-convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 20 cm ? [NCERT]
- (1) ∞ (2) 5 cm
(3) 20 cm (4) 22 cm
16. A beam of light converge at a point P. Now a lens is placed in the path of the convergent beam 12 cm from P. If the lens is a convex lens of focal length 20 cm the beam converge at a point :- [NCERT]
- (1) -15cm (2) +7.5cm
(3) -20cm (4) +15cm
17. In the above problem if the lens is a concave lens of focal length 16 cm then the beam converge at a point :- [NCERT]
- (1) +48 cm (2) +6.75 cm
(3) -48 cm (4) -6.75 cm
18. An object of size 3 cm is placed 14 cm in front of a concave lens of focal length 21 cm. Describe the image produced by the lens.
- (1) Virtual, erect, diminished [NCERT]
(2) Virtual, erect, enlarged
(3) Real, inverted, enlarged
(4) Real, inverted, diminished
19. What is the focal length when a convex lens of focal length 30 cm in contact with a concave lens of focal length 20 cm ? [NCERT]
- (1) -12 cm (2) 12 cm
(3) -60 cm (4) +60 cm
20. In the above problem is the system a converging or a diverging lens ? [NCERT]
- (1) Plane glass plate
(2) Converging lens
(3) Diverging lens
(4) Either converging or diverging depending on position of object
21. Determine the nature of lens shown in figure (P) & (Q) (given lenses are made from glass & surrounding medium is air)

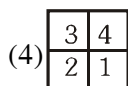
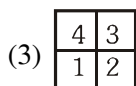
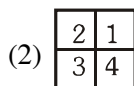
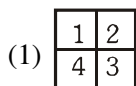


- (1) P $\rightarrow$ converging & Q $\rightarrow$ diverging
(2) P $\rightarrow$ diverging & Q $\rightarrow$ converging
(3) P & Q both converging
(4) P & Q both diverging

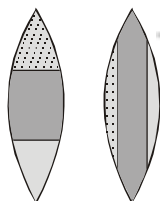
22. A convex lens is used to form a real image of the object as shown in the figure.



Then the real inverted image is as shown in the following figure :-



23. Figure shows two convex lenses A and B, each made up of three different transparent materials. The number of images formed, of an object kept on the principal axis of each lens will be



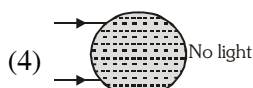
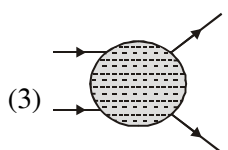
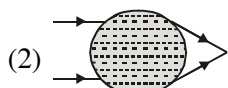
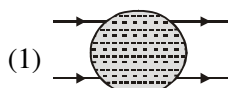
(1) 3 and 3

(2) 3 and 1

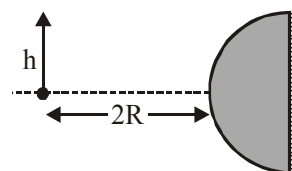
(3) 1 and 1

(4) 3 and 2

24. A water drop in air refracts the light ray as-

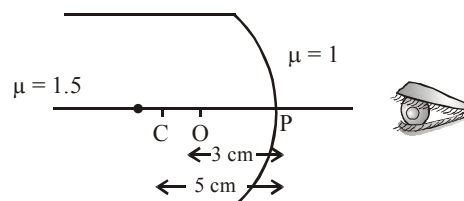


25. A glass hemisphere of radius R and material having refractive index 1.5 is silvered on its flat face as shown in the figure. A small object of height h is located at a distance $2R$ from surface of hemisphere. The final image will form :-



- (1) at a distance of R from silvered surface, on right side
(2) on the hemispherical surface
(3) at the plane surface
(4) at a distance of $2R$ from the curved surface on left side

26. An bubble in glass ($\mu = 1.5$) is situated at a distance 3 cm from a convex surface of diameter 10 cm as shown in figure. At what distance from the surface will the bubble appear:



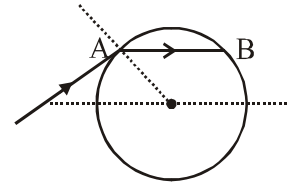
- (1) 2.5 cm (2) 2 cm (3) 3 cm (4) 4 cm

27. One end of a cylindrical glass rod ($\mu = 1.5$) is in the shape of a concave refraction surface of radius 10 cm. An air bubble is situated in the glass rod at a point on its axis such that it appears to be at a distance 10 cm from the surface inside the glass when seen from the other medium. find the actual location of air bubble from the surface.

- (1) 10 cm inside the glass
(2) 20 cm outside the glass
(3) 30 cm inside the glass
(4) 40 cm inside the glass

28. A mark on the surface of a glass sphere ($\mu = 1.5$) is viewed from diametrically opposite position. It appears to be at a distance 10 cm from behind its actual position then find the radius of sphere
- (1) 10 cm (2) 8 cm (3) 6 cm (4) 5 cm

29. What should be the angle of incidence at A of the spherical glass placed in air so that so that grazing emergence of light ray takes place at B?



- (1) 30° (2) 45° (3) 60° (4) 90°

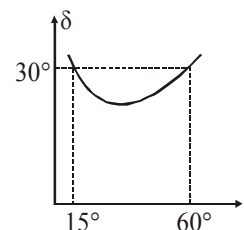
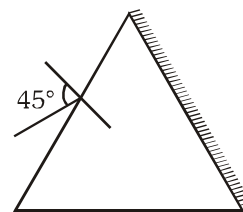
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	3	3	2	2	2	2	2	4	4	1	2	4	1	2	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Ans	2	1	1	3	3	3	3	4	2	4	1	3	4	4	

RAY OPTICS (PRISM)

RACE # 05

- A prism of refracting angle 60° has minimum angle of deviation of 30° . What must be the angle of incidence for this case ?
(1) 0° (2) 90° (3) 45° (4) 30°
- A ray of light passes through an equilateral prism ($\mu = 1.5$). The angle of minimum deviation is
(Given $\sin 49^\circ = 0.75$)
(1) 45° (2) 38° (3) 20° (4) 30°
- Angle of minimum deviation for a prism of refractive index $\sqrt{3}$, is equal to the angle of the prism. Then the angle of the prism is :-
(1) 60° (2) 41° (3) 82° (4) 31°
- A ray of light is incident at an angle of 60° on one face of a prism of angle 30° . The emergent ray of light makes an angle of 30° with incident ray. The angle made by emergent ray with second face of prism will be :-
(1) 0° (2) 90° (3) 45° (4) 30°
- In question 4, the angle of refraction (r_2) at IInd face of prism will be :-
(1) 0° (2) 90° (3) 45° (4) 30°
- In question 4, the angle of refraction (r_1) at 1st face of prism will be :-
(1) 0° (2) 90° (3) 45° (4) 30°
- In question 4, the refractive index of material of prism will be (Given $\cos 15^\circ = 0.9659$)
(1) 1.33 (2) 1.5 (3) 1.414 (4) 1.732
- A thin prism P_1 with angle 5° and made from glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.92 to produce dispersion without deviation. The angle of prism P_2 is :-
(1) 5.33° (2) 4° (3) 5° (4) 2.9°
- A ray incident at 45° on one refracting surface of a prism of angle 60° suffers a deviation of 55° . What is the angle of emergence ?
(1) 95° (2) 45° (3) 30° (4) 70°
- When a ray of light is incident at angle of 35° on an equilateral prism. Then it passes symmetrically. Calculate the deviation of the ray. (Symmetrically means parallel to base)
(1) 30° (2) 15°
(3) 10° (4) 45°
- A prism is made of glass of unknown refractive index. A parallel beam of light is incident on a face of the prism. The angle of minimum deviation is measured to be 30° . What is refractive index of the material of the prism ? (Refracting angle of prism is 60°)
(1) 1.414 (2) 1.5
(3) 1.7 (4) None of these
- Calculate the dispersive power of a crown glass prism if refractive index of red and violet colours for crown glass are respectively 1.52 and 1.64.
(1) 3.67 (2) 0.206
(3) 1.58 (4) 12.03
- Calculate the angular dispersion produced by a thin prism of angle 12° if refractive index for red and violet colours are respectively 1.56 and 1.68.
(1) 1.44° (2) 2°
(3) 2.05° (4) None
- One face of a prism with a refracting angle 30° is coated with silver. A ray is incident on another face at an angle of 45° is refracted and reflected from the silver coated face & retraces its path. The refractive index of prism is
(1) $\sqrt{2}$
(2) 2
(3) $\sqrt{3}$
(4) 1.5
- Figure shows graph of deviation δ versus angle of incidence for a light ray striking a prism. Angle of prism is :-
(1) 30°
(2) 45°
(3) 60°
(4) 75°

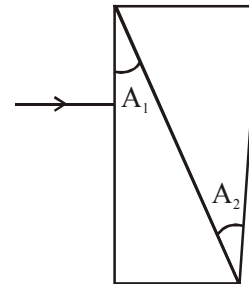


16. A ray of light is incident on a face of equilateral triangle at an incident angle 40° . At this angle, minimum deviation occurs. The value of the deviation is

- (1) 60° (2) 10°
 (3) 20° (4) 40°

17. An achromatic combination is made by combining 2 prisms as shown.

If $\omega_1 > \omega_2$ then



- (1) Average deviation would be clockwise
 (2) Average deviation would be anticlockwise
 (3) Average deviation would be zero
 (4) Cannot be predicted on basis of given information

Tg: @Chalnaayaaar

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	3	2	1	2	1	4	4	4	4	3	1	2	1	1	2
Que.	16	17													
Ans	3	2													

RAY OPTICS (OPTICAL INSTRUMENTS, DEFECTS OF EYE)

RACE # 06

1. A man uses a convex lens of focal length 5 cm as magnifying glass. The least distance of distinct vision of the man is 25 cm. Calculate the magnification if the image is formed at the least distance of distinct vision.
(1) 1.5 (2) 3 (3) 4 (4) 6
2. In question number 1 calculate the distance of the object from the lens.
(1) 25 cm (2) 5.53 cm (3) 4.16 cm (4) None
3. The focal length of the objective and eye piece of a microscope are respectively 1cm and 2cm. The distance between them is 12 cm. Where an object should be placed in order to view it at the least distant of distinct vision.
(1) 4.05 cm (2) 0.05 cm
(3) 2.05 cm (4) 1.1 cm
4. An astronomical telescope has an eye piece of focal length 5 cm. If magnification produced is 14 in normal adjustment, then calculate the length of the telescope.
(1) 75cm (2) 9cm (3) 50cm (4) 55cm
5. An astronomical telescope of length 50 cm produces a magnification of 9 in normal adjustment. Calculate focal length of its objective and eye piece.
(1) 4cm, 2cm (2) 30cm, 5cm
(3) 55cm, 10cm (4) 45cm, 5 cm
6. The maximum distance up to which a man can see distinctly is 200 cm. What lens & of which focal length he should use in order to see distant objects distinctly?
(1) Convex lens, + 200 cm
(2) Concave lens, – 200 cm
(3) Convex lens, + 50 cm
(4) Concave lens, – 50 cm
7. A man cannot see any object beyond 75 cm away. What should be the power of spectacle lens to see distant objects?
(1) –1D (2) –2D
(3) – 1.33D (4) – 0.75D
8. A man can see objects clearly only up to 3 meter. What should be the focal length of the lens to see clearly upto 12 m.
(1) –4 m (2) +0.25 m
(3) –33.33 m (4) +4m
9. A man can see distinctly from a distance of 0.5 metre. If he wants to read a book placed at a distance of 25 cm, then what should be the power of lens.
(1) – 2.5D (2) – 1.5D
(3) – 2D (4) +2D
10. A compound microscope consists of an objective lens of focal length 2 cm and an eye piece of focal length 6.25 cm separated by a distance of 15 cm. How far from the objective should an object be placed in order to obtain the final image at the least distance of distinct vision (25 cm). [NCERT]
(1) 2.5 cm (2) 1.67 cm
(3) 2 cm (4) 3.3 cm
11. A person with a normal near point (25 cm) using a compound microscope with objective of focal length 8.0 mm and an eye piece of focal length 2.5 cm can bring an object placed at 9 mm from the objective in sharp focus. What is the separation between two lenses ? [NCERT]
(1) 9.46 cm (2) 4.85 cm
(3) 5.73 cm (4) None of these
12. In the above problem, calculate the magnifying power of the microscope :- [NCERT]
(1) 34 (2) 50 (3) 88 (4) 102
13. A small telescope has an objective lens of focal length 144 cm and an eye piece of focal length 6 cm. Find the magnifying power and separation between the objective and the eye piece :- [NCERT]
(1) +24, 148 cm (2) –24, 150 cm
(3) 10, 138 cm (4) 3, 75 cm

- 14.** A giant refracting telescope at an observatory has an objective lens of focal length 15 m. If an eye piece of focal length 1.0 cm is used What is the angular magnification of the telescope :-
[NCERT]
(1) 1.5 (2) 1500
(3) 15 (4) 150
- 15.** In the above problem, if this telescope is used to view the moon, what is the diameter of the image of the moon formed by the objective lens ? (diameter of moon is 3.48×10^6 m and radius of lunar orbit is 3.8×10^8 m) [NCERT]
(1) 1.3 cm (2) ∞
(3) 8.5 cm (4) 13.74 cm
- 16.** A man with normal near point (25 cm) reads a book with small print using a magnifying glass : a thin convex lens of focal length 5 cm. What is the closest and the farthest distance at which he should keep the lens from the page so that he can read the book when viewing through the magnifying glass ? [NCERT]
(1) -4.8 cm, -5.2 cm
(2) -4.2 cm, -5 cm
(3) -6.2 cm, -8 cm
(4) -9 cm, -2.9 cm
- 17.** In the above problem, what is the maximum and minimum angular magnification possible using the above simple microscope ? [NCERT]
(1) 10, 5 (2) 6, 5
(3) 3, 2 (4) 3, 7
- 18.** A card sheet divided into square each of size 1 mm^2 is being viewed at a distance of 9 cm through a magnifying glass (a converging lens of focal length 10 cm) held close to the eye. What is the magnification produced by the lens?
[NCERT]
(1) $\frac{10}{19}$ (2) 9 (3) 10 (4) 5
- 19.** In the above problem, how much is the area of each square in the virtual image ? [NCERT]
(1) 100 mm^2 (2) 50 mm^2
(3) 25 mm^2 (4) None of these
- 20.** In the above problem, what is the angular magnification (magnifying power) of the lens?
[NCERT]
(1) 2.0 (2) 6
(3) 2.8 (4) 3.2
- 21.** In the above problem, at what distance should the lens be held from the figure in order to view the squares distinctly with the maximum possible magnifying power ? [NCERT]
(1) 16.67
(2) 1.33
(3) 10.03
(4) 7.14 cm
- 22.** In the above problem, what is the magnification in this case ? [NCERT]
(1) 3.5 (2) 4.5
(3) 5.3 (4) 5.4
- 23.** An angular magnification (magnifying power) of 30X is desired using an objective of focal length 1.25 cm and an eye piece of focal length 5 cm. How will you setup the compound microscope for normal adjustment ? [NCERT]
(1) Separation between both lenses 13.75 cm
(2) Separation between both lenses 15.51 cm
(3) Separation between both lenses 6.25 cm
(4) Separation between both lenses 9.0 cm
- 24.** A small telescope has an objective lens of focal length 140 cm and an eye piece of focal length 5 cm. What is the magnifying power of the telescope for viewing distant objects when the telescope is in normal adjustment (i.e. when the final image is at infinity) [NCERT]
(1) 13 (2) 7
(3) 6 (4) 28
- 25.** In the Q.No. 24, the final image is formed at the least distance of distinct vision (25 cm) then magnification will be :- [NCERT]
(1) 28 (2) 33.6
(3) 72 (4) ∞

26. In the Q.No. 24, what is the separation between the objective lens and the eyepiece ? [NCERT]

- (1) 145 cm
- (2) 135 cm
- (3) 105 cm
- (4) 75 cm

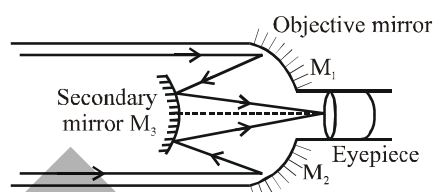
27. In the Q.No. 24, if this telescope is used to view a 100 m tall tower 3 km away, what is the height of the image of the tower formed by the objective lens ? [NCERT]

- (1) 2 cm
- (2) 5.3 cm
- (3) 4.7 cm
- (4) 7 cm

28. In the Q.No. 27, what is the height of the final image of the tower if it is formed at 25 cm?

- (1) 18.8 cm
- (2) 32 cm [NCERT]
- (3) 28 cm
- (4) None of these

29. A instrument uses two mirror as shown in figure. Such instrument is built with the mirrors 20 mm apart. If the radius of curvature of the large mirror is 220 mm and the small mirror is 140 mm. Where will the final image from M_3 of an object at infinity be ? [NCERT]



- (1) 21 cm
- (2) 31.5 cm
- (3) 27.5 cm
- (4) 19 cm

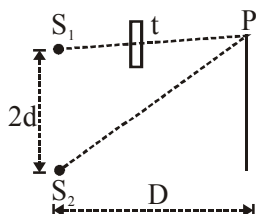
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	4	3	4	1	4	2	3	1	4	1	1	3	2	2	4
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Ans	2	2	3	1	3	4	1	1	4	2	1	3	3	2	

WAVE NATURE OF LIGHT & WAVE OPTICS (INTERFERENCE) RACE # 01

- In an interference pattern, at a point we observe the 16th order bright fringe or maxima for $\lambda_1 = 7200 \text{ \AA}$. What order will be visible here if the source is replaced by light of wavelength $\lambda_2 = 4800 \text{ \AA}$.
 (1) 12 (2) 24
 (3) 36 (4) 16
- To demonstrate the phenomena of interference, we require :-
 (1) two sources which emit radiation of same frequency
 (2) two sources which emit radiation of nearly same frequency
 (3) two sources which emit radiation of the same frequency and have a definite phase relationship
 (4) two sources which emit radiation of different wavelengths
- In the Young's double slit experiment, the interference pattern is found to have an intensity ratio between bright and dark fringes, as 9. This implies that :-
 (1) the intensities ratio of sources is 5
 (2) the intensities ratio of sources is 4
 (3) the amplitude ratio of sources is 3
 (4) the amplitude ratio of sources is 2
- In Young's double slit interference experiment, the distance between two sources is 0.1 mm. The distance of the screen from the sources is 20 cm. Wavelength of light used is $5460 \text{ \AA}$. Then the angular position of the first dark fringe is :-
 (1) 0.08°
 (2) 0.16°
 (3) 0.20°
 (4) 0.32°
- White light is used to illuminate the two slits in a Young's double slit experiment. The separation between slits is b and the screen is at a distance d ($\gg b$) from the slits. At a point on the screen directly in front of one of the slits, certain wavelengths are missing. Some of these missing wavelengths are :-
 (1) $\lambda = b^2/d$
 (2) $\lambda = 2b^2/d$
 (3) $\lambda = b^2/3d$
 (4) $\lambda = 2b^2/3d$
- Two light rays having the same wavelength λ in vacuum are in phase initially. Then the first ray travels a path of length L_1 through a medium of refractive index n_1 while the second ray travels a path of length L_2 through a medium of refractive index n_2 . The two waves are then combined to observe interference. The phase-difference between the two waves is :-
 (1) $\frac{2\pi}{\lambda}(L_2 - L_1)$
 (2) $\frac{2\pi}{\lambda}(n_1 L_1 - n_2 L_2)$
 (3) $\frac{2\pi}{\lambda}(n_2 L_1 - n_1 L_2)$
 (4) $\frac{2\pi}{\lambda} \left(\frac{L_1}{n_1} - \frac{L_2}{n_2} \right)$
- In two separate setup of the Young's double slit experiment, fringes of equal width are observed when lights of wavelengths in the ratio 1 : 2 are used. If the ratio of the slit separation in the two cases is 2 : 1, the ratio of the distances between the plane of the slits and the screen, in the two setup is :-
 (1) 4 : 1
 (2) 1 : 1
 (3) 1 : 4
 (4) 2 : 1

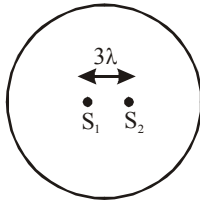
8. If a thin mica sheet of thickness t and refractive index $\mu = (5/3)$ is placed in the path of one of the interfering beams as shown in figure, then the displacement of the fringe system is :-



- (1) $\frac{Dt}{3d}$ (2) $\frac{Dt}{5d}$
(3) $\frac{Dt}{4d}$ (4) $\frac{2Dt}{5d}$
9. A thin sheet of glass ($\mu = 1.5$) of thickness 6 microns introduced in the path of one of interfering beams in a double slit experiment shifts the central fringe to a position previously occupied by fifth bright fringe. Then the wavelength of light used is :-
(1) 6000 Å
(2) 3000 Å
(3) 4500 Å
(4) 7500 Å
10. When light wave travelling in air suffers reflection at the interface between air and glass, the change of phase of the reflected wave is equal to :-
(1) zero (2) $\pi/2$
(3) π (4) 2π
11. The maximum number of possible interference maxima for slit separation equal to two and half times the wavelength in Youngs double slit experiment in :-
(1) Infinite (2) Five
(3) Three (4) Zero

12. Huygens concepts of secondary wavelets :-
(1) Allow us to find focal length of a thin lens
(2) Give the magnifying power of a microscope
(3) Are a geometrical method to find a wavefront
(4) Are used to determine the velocity of light
13. If Young's experiment is performed using two separate identical sources of light instead of using two slits and one light source then the :-
(1) Interference fringes will be darker
(2) Interference fringes will be brighter
(3) Fringes will not be obtained
(4) Contrast between bright and dark fringes increases
14. The beautiful iridescent (like a rainbow) colors on the wings or Some currency notes (to avoid counterfeits) change their colour as you tilt them. This is due to :-
(1) Refraction
(2) Superposition of light
(3) Polarization of light
(4) Dispersion of light
15. The central fringe of the interference pattern produced by light of wavelength 6000 Å is found to shift to the position of 4th bright fringe after a glass plate of refractive index 1.5 is introduced in front of one slit in Young's experiment. The thickness of the glass plate will be :-
(1) 4.8 μm (2) 8.23 μm
(3) 14.98 μm (4) 3.78 μm
16. In Young's double slit experiment, the intensity of light at a point on the screen where the path difference is λ is I_0 . The intensity of light at a point where the path difference becomes $\frac{\lambda}{3}$ is:-
(1) I_0 (2) $\frac{I_0}{4}$
(3) $\frac{I_0}{3}$ (4) $\frac{I_0}{2}$

17. If two coherent sources are placed at a distance 3λ from each other symmetric to the centre of the circle shown in the figure, then number of maxima shown on the screen placed along the circumference is :-



- (1) 16 (2) 12 (3) 8 (4) 4

Tg: @Chalnaayaaar

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	2	3	2,4	2	1,3	2	1	1	1	3	2	3	3	2	1
Que.	16	17													
Ans	2	2													

WAVE NATURE OF LIGHT & WAVE OPTICS

RACE # 02

(DIFFRACTION, POLARISATION & RESOLVING POWER)

- Diffraction and refraction indicate :-
(1) wave nature (2) particle nature
(3) both 1 and 2 (4) none of these
- Light of wavelength λ is incident on a slit of width d . The resulting diffraction pattern is observed on a screen at a distance D . The linear width of the central maxima equal to width of the slit if D equals
(1) d/λ (2) $2\lambda/d$
(3) $d^2/2\lambda$ (4) $2\lambda^2/d$
- Light of wavelength $6328 \text{ \AA}$ is incident normally on a slit having a width of 0.2 mm . The width of the central maximum measured from minimum to minimum of diffraction pattern on a screen 9.0 metres away from slit will be about :-
(1) 0.36 degrees (2) 0.18 degrees
(3) 0.72 degrees (4) 0.09 degrees
- The main difference in the phenomenon of interference and diffraction is that :-
(1) diffraction is due to interaction of light from the same wavefront whereas interference is the interaction of waves from two isolated sources.
(2) diffraction is due to interaction of light from wavefront, whereas the interference is the interaction of two waves derived from the same source.
(3) diffraction is due to interaction of waves derived from the same source, whereas the interference is the bending of light from the same wavelength.
(4) diffraction is caused by reflected waves from a source whereas interference caused is due to refraction of waves from a surface.
- Light waves can be polarised because they :-
(1) have high frequencies
(2) have short wavelength
(3) are transverse
(4) can be reflected
- If the light is polarised by reflection, then the angle between reflected and refracted light is :-
(1) π (2) $\pi/2$ (3) 2π (4) $\pi/4$
- In the propagation of light waves, the angle between the plane of vibration and the plane of polarisation is
(1) 0° (2) 90° (3) 45° (4) 180°
- A ray of light strikes a glass plate at an angle of 60° . If the reflected and refracted rays are perpendicular to each other, the index of refraction of glass is :-
(1) $\sqrt{3}$ (2) $3/2$ (3) $\sqrt{3/2}$ (4) $1/2$
- When unpolarised light is incident on a plane glass plate at Brewster's (polarising) angle, then which of the following statements is correct :-
(1) reflected and refracted rays are completely polarised with their planes of polarisation parallel to each other.
(2) reflected and refracted rays are completely polarised with their planes of polarisation perpendicular to each other
(3) the reflected light is plane polarised
(4) the reflected light is partially polarised but refracted light is plane polarised
- Choose the correct statement
(1) the Brewster's angle is independent of wavelength of light
(2) the Brewster's angle is independent of nature of reflection surface
(3) the Brewster's angle is different for different wavelengths
(4) Brewster's angle depends on wavelength but not on the nature of reflecting surface
- Two point separates by distance of 0.1 mm can just be inspected in a microscope when light of wavelength $6000 \text{ \AA}$ is used, when light of wavelength $4800 \text{ \AA}$ is used then limit of resolution will become
(1) 0.80 mm (2) 0.12 mm
(3) 0.10 mm (4) 0.08 mm

12. The angular resolution of 10 cm diameter telescope at a wavelength of $5000\text{\AA}$ is of the order of :-
 (1) 10^{-4} rad
 (2) 10^{-6} rad
 (3) 10^6 rad
 (4) 10^{-2} rad
13. The aperture of the largest telescope in the world is 5 m, if the separation between the moon and the earth is 4×10^5 km and the wavelength of the visible light is $5000\text{\AA}$ then the minimum separation between objects on the surface of the moon which can be just resolve is approximately
 (1) 1 m (2) 10 m
 (3) 50 m (4) 200 m
14. In a Fraunhofer diffraction experiment at a single slit using light of wavelength 400 nm, the first minimum is formed at an angle of 30° . Then the direction θ of the first secondary maximum is :-
 (1) $\tan^{-1}\left(\frac{4}{3}\right)$ (2) 60°
 (3) $\sin^{-1}\left(\frac{3}{4}\right)$ (4) $\tan^{-1}\left(\frac{3}{4}\right)$
15. In propagation of light waves, the angle between the direction of propagation and plane of polarization is
 (1) 0° (2) 45° (3) 90° (4) 180°

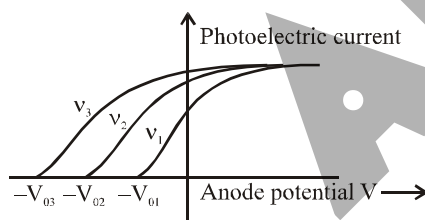
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	1	3	1	2	3	2	2	1	3	3	4	2	3	3	1

Modern Physics (Photo Electric Effect)

RACE # 01

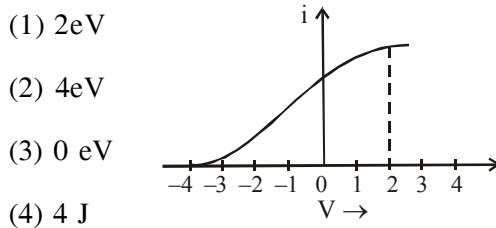
- Energy of a quanta of frequency 10^{15} Hz and $h = 6.6 \times 10^{-34}$ J.S will be
 (1) 6.6×10^{-19} J (2) 6.6×10^{-12} J
 (3) 6.6×10^{-49} J (4) 6.6×10^{-41} J
- Consider a parallel beam of light of wavelength 600 nm and intensity 100 W/m^2 . How many photons cross 1 cm^2 area perpendicular to beam in one second ?
 (1) 3×10^{16} (2) 3×10^{14}
 (3) 3×10^9 (4) 3×10^4
- When light of wavelength 300 nm falls on a photoelectric emitter, photoelectrons are just liberated. For another emitter, light of wavelength 600 nm is just sufficient for liberating photoelectrons. The ratio of the work function of the two emitters is :-
 (1) 1 : 2 (2) 2 : 1
 (3) 4 : 1 (4) 1 : 4
- In photoelectric effect, the curve between photoelectric current and anode potential V (For different frequencies) is shown in figure, then



- $v_1 > v_2 > v_3$
 - $v_1 < v_2 < v_3$
 - $v_1 = v_2 = v_3$
 - $v_1 > v_2 < v_3$
- The number of photo-electrons emitted per second from a metal surface increases when
 (1) The energy of incident photons increases
 (2) The frequency of incident light increases
 (3) The wavelength of incident light increases
 (4) The intensity of incident light increases
- Wave nature of light cannot explain photoelectric effect because in photoelectric effect, it is seen that :
 (1) For the frequency of light below a certain value, the photoelectric effect does not take place, irrespective of intensity
 (2) Maximum kinetic energy of ejected electrons is independent of intensity of radiation
 (3) There is no time lag between the incidence of radiation and emission of electrons
 (4) All of these
- When photon of energy 3.8 eV falls on metallic surface of work function 2.8 eV, then the kinetic energy of emitted electrons are :-
 (1) 1 eV (2) 6.6 eV
 (3) 0 to 1 eV (4) 2.8 eV
- A monochromatic point source of light is placed at a distance d from a metal surface. Photoelectrons are ejected at a rate n per second, and with maximum kinetic energy E. If the source is brought nearer to distance d/2, the rate and the maximum kinetic energy per photoelectron become nearly
 (1) 2n and 2E (2) 4n and 4E
 (3) 4n and E (4) n and 4E
- Maximum velocity of the photoelectrons emitted by a metal surface is $1.2 \times 10^6 \text{ ms}^{-1}$. Assuming the specific charge of the electron to be $1.8 \times 10^{11} \text{ C kg}^{-1}$, the value of stopping potential (in volt) will be :-
 (1) 2 (2) 3 (3) 4 (4) 6
- If in a photoelectric experiment the wavelength of incident radiation is reduced from 6000 Å to 4000 Å then :
 (1) Stopping potential will decrease
 (2) Stopping potential will increase
 (3) Kinetic energy of emitted electrons will decrease
 (4) The value of work function will decrease

11. Given that a photon of light of wavelength $10000\text{\AA}$ has energy 1.23 eV . Now when light of intensity I_0 and wavelength $5000\text{\AA}$ falls on a photo cell the saturation current and stopping potential are $0.40\text{ }\mu\text{A}$ and 1.36 V respectively. The work function is:-
- (1) 0.43 eV (2) 1.10 eV
(3) 1.36 eV (4) 2.47 eV

12. Figure represents the graph of photo current i versus applied voltage (V). The maximum kinetic energy of the emitted photoelectrons is:-



- (1) 2 eV
(2) 4 eV
(3) 0 eV
(4) 4 J

13. Two identical metal plates show photoelectric effect by a light of wavelength λ_A falling on plate A and λ_B on plate B ($\lambda_A = 2\lambda_B$). The maximum kinetic energy is :-
- (1) $2K_A = K_B$ (2) $K_A < K_B/2$
(3) $K_A = 2K_B$ (4) $K_A > K_B/2$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	
Ans	1	1	2	2	4	4	3	3	3	2	2	2	2	

MODERN PHYSICS (MATTER WAVES)

RACE # 02

- Which of the following figures represents the variation of particle momentum (p) and associated de Broglie wavelength (λ) ?

(1)

(2)

(3)

(4)
- Which one of the following statements is not true about de-Broglie waves ?
 - All atomic particles in motion have waves character associated with them
 - The higher the momentum, the longer is the wave-length
 - The faster the particle, the shorter is the wavelength
 - For the same velocity, a heavier particle has a shorter wavelength
- Choose the only correct statement out of the following :
 - Only a charged particle in motion is accompanied by matter waves
 - Only subatomic particles in motion are accompanied by matter waves
 - Any particle in motion, whether charged or uncharged is accompanied by matter waves
 - No particle, whether at rest or in motion, is ever accompanied by matter waves
- What will be the ratio of de-Broglie wavelength of proton and α -particle of same energy :

(1) 2 : 1

(2) 1 : 2

(3) 4 : 1

(4) 1 : 4
- The de-Broglie wavelength of photoelectrons is $1\text{ \AA}$. Its accelerating potential is :

(1) 150 V

(2) 15.3 V

(3) 12.3 V

(4) 13.6 V
- If the kinetic energy of a free electron doubles, its de-Broglie wavelength changes to the factor:

(1) $\frac{1}{\sqrt{2}}$

(2) $\sqrt{2}$

(3) $1/2$

(4) 2
- De-broglie wavelength of a body of mass 1 kg moving with velocity of 2000 m/s is :

(1) $3.32 \times 10^{-27} \text{ \AA}$

(2) $1.5 \times 10^7 \text{ \AA}$

(3) $0.55 \times 10^{-22} \text{ \AA}$

(4) $2 \times 10^{20} \text{ \AA}$
- The de-Broglie wavelength of an electron and the wavelength of a photon are the same. The ratio between the energy of that photon and the momentum of that electron is :-

(1) h

(2) c

(3) $\frac{1}{h}$

(4) $\frac{1}{c}$
- The de Broglie wavelength of an electron in the n^{th} Bohr orbit is related to the radius R of the orbit as :-

(1) $n\lambda = \pi R$

(2) $n\lambda = \frac{3}{2} \pi R$

(3) $n\lambda = 2\pi R$

(4) $n\lambda = 4\pi R$
- Find an expression for de Broglie wavelength for an electron in the n^{th} orbit of the Bohr model of the hydrogen atom and hence find its value when the electron is in $n = 4$ level.
Take radius of n^{th} orbital of Bohr's model of H-atom; $r_n = (53 n^2) \text{ pm}$

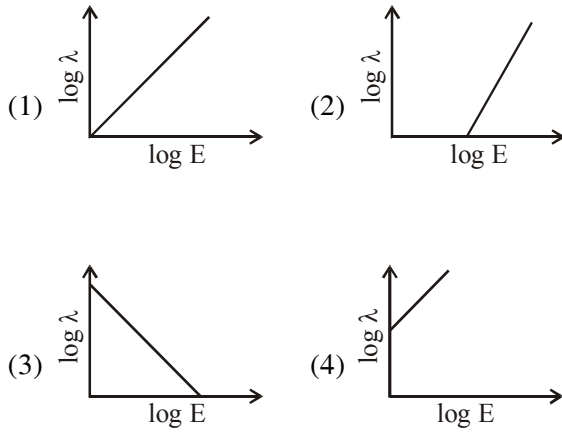
(1) 1.33 nm

(2) 1.20 nm

(3) 1.50 nm

(4) None

11. The log-log graph between the energy E of an electron and its de-Broglie wavelength λ will be:-



Tg: @Chalnaayaaar

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	
Ans	4	2	3	1	1	1	1	2	3	1	3	

MODERN PHYSICS (RADIOACTIVITY)

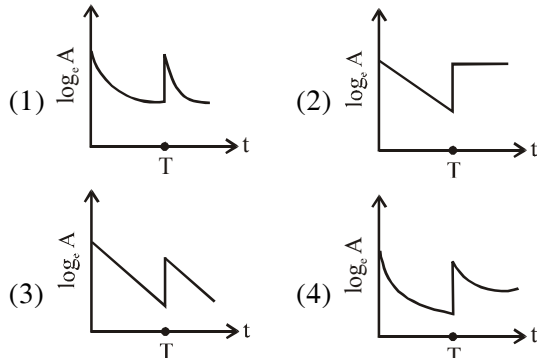
RACE # 03

- A nucleus X undergoes following transformation

$$X \xrightarrow{\alpha} Y \text{ then } Y \xrightarrow{2\beta} Z$$
 - X and Y are isotopes
 - X and Z are isobars
 - X and Y are isobars
 - X and Z are isotopes
- What are the respective number α - and β -particles emitted in the following radioactive decay ?

$${}_{90}^{200}\text{X} \rightarrow {}_{80}^{168}\text{Y}$$
 - 6 and 8
 - 6 and 6
 - 8 and 8
 - 8 and 6
- Out of the following, which one is not emitted by a natural radioactive substance ?
 - Electrons
 - Electromagnetic radiations
 - Helium nuclei with charge equal to that of two protons
 - Neutrons
- γ -decay occurs when
 - Pair annihilation takes place
 - Energy is released due to conversion of neutron into proton
 - Energy is released due to de-excitation of nucleus
 - None of these
- In the equation : ${}_{13}^{27}\text{Al} + {}_2^4\text{He} \longrightarrow {}_{15}^{30}\text{P} + \text{X}$,
The correct symbol for X is :-
 - ${}_{-1}^0\text{e}$
 - ${}_1^1\text{H}$
 - ${}_2^4\text{He}$
 - ${}_0^1\text{n}$
- The sample of a radioactive substance has 10^6 nuclei. Its half life is 20 s. The number of nuclei that will be left after 10 s is nearly :-
 - 1×10^5
 - 2×10^5
 - 7×10^5
 - 11×10^5
- Two radioactive isotopes P and Q have half lives 10 minutes and 15 minutes respectively. Freshly prepared samples of each isotope initially contain the same number of atoms. After 30 minutes, the ratio $\frac{\text{number of atoms of P}}{\text{number of atoms of Q}}$ will be :-
 - 0.5
 - 2.0
 - 1.0
 - 3.0
- During a mean-life of a radioactive element, the fraction that disintegrates is :
 - e
 - $1/e$
 - $\frac{e-1}{e}$
 - $\frac{e}{e-1}$
- Two radioactive materials X_1 and X_2 have decay constants 10λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that of X_2 will be $\frac{1}{e}$ after a time.
 - $\frac{1}{10\lambda}$
 - $\frac{1}{11\lambda}$
 - $\frac{11}{10\lambda}$
 - $\frac{1}{9\lambda}$
- The half life of radon is 3.8 days. After how many days, will one-twentieth of radon sample be left over ?
 - 16.425
 - 15.425
 - 18.725
 - 1.301
- The decay rate of sample of radioactive nuclide I^{128} after time 4 min and 36 min is 322 and 161 counts/s. Find half life for this radionuclide.
 - 28 min
 - 32 min
 - 16 min
 - 40 min
- Half life of substance is 20 min, then the time between 33% decay and 67% decay will be :-
 - 20 min
 - 40 min
 - 50 min
 - 10 min
- The count rate of radioactive source at $t = 0$ was 1600 count/s and $t = 8\text{s}$, it was 100 count/s. The count rate (in counts) at $t = 6\text{s}$ was
 - 150
 - 200
 - 300
 - 400

14. At time $t = 0$ some radioactive gas is injected into a sealed vessel. At time T some more of the gas is injected into the vessel. Which one of the following graphs best represents the logarithm of the activity A of the gas with time t ?



15. A sample of radioactive material decays simultaneously by two processes A and B with half lives $\frac{1}{2}$ and $\frac{1}{4}$ hr respectively. For first half hr it decays with the process A, next one hr with the process B and for further half an hour with both A and B. If originally there were N_0 nuclei, find the number of nuclei after 2 hr of such decay :-

- (1) $\frac{N_0}{(2)^8}$ (2) $\frac{N_0}{(2)^4}$ (3) $\frac{N_0}{(2)^6}$ (4) $\frac{N_0}{(2)^5}$

16. There are three lumps of a given radioactive substance. Their activity is in the ratio of $1 : 2 : 3$ now. What will be the ratio of their activities at any further date -

- (1) $1 : 2 : 3$ (2) $2 : 1 : 3$
(3) $3 : 2 : 1$ (4) $2 : 3 : 1$

17. The half-life of I^{131} is 8 days. Given a sample of I^{131} at time $t = 0$, we can assert that :-

- (1) No nucleus will decay before $t = 4$ days
(2) No nucleus will decay before $t = 8$ days
(3) All nuclei will decay before $t = 16$ days
(4) A given nucleus may decay at any time after $t = 0$

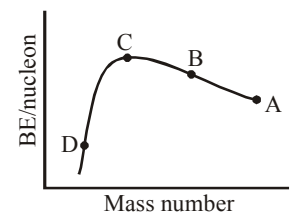
18. A radioactive sample S_1 having the activity A_1 has twice the number of nuclei as another sample S_2 of activity A_2 . If $A_2 = 2A_1$, then the ratio of half life of S_1 to the life of S_2 is :

- (1) 4 (2) 2 (3) 0.25 (4) 0.75

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	4	4	4	3	4	3	1	3	4	1	2	1	2	3	1
Que.	16	17	18												
Ans	1	4	1												

- Ratio of nuclear radii of ^{135}Cs to ^{40}Ca is :
(1) 1.40 (2) 1.50
(3) 2.750 (4) 3.375
- A nucleus at rest breaks into two nuclear parts which have their velocities ratio equal to 2 : 1. What will be the ratio of their nuclear radii ?
(1) $2^{1/3} : 1$ (2) $1 : 2^{1/3}$
(3) $2^{3/2} : 1$ (4) $1 : 2^{3/2}$
- Which of the following pairs of particles cannot exert nuclear force on each other ?
(1) Proton and electron
(2) Neutron and electron
(3) Electron and neutron
(4) All of these
- Binding energy of $^2\text{He}^4$ and $^3\text{Li}^7$ are 27.37 MeV and 39.3 MeV respectively. Which of the two nuclei is more stable ?
(1) He^4 (2) Li^7 (3) Equally (4) Can't decide
- The average binding energy per nucleon of a nucleus is of the order of :
(1) 8 eV (2) 8 J (3) 8 keV (4) 8 MeV
- The binding energy per nucleon for a deuteron and an α -particle are x_1 and x_2 respectively. The energy (Q) released in the reaction $^2_1\text{H} + ^2_1\text{H} \rightarrow ^4_2\text{He} + Q$ is :
(1) $2(x_2 - x_1)$ (2) $2(x_1 + x_2)$
(3) $4(x_1 + x_2)$ (4) $4(x_2 - x_1)$
- The binding energies of the nuclei A and B are E_a and E_b respectively. Three atoms of the element B fuse to give one atom of element A and an energy Q is released. Then E_a , E_b and Q are related :-
(1) $E_a - 3E_b = Q$ (2) $3E_b - E_a = Q$
(3) $E_a + 3E_b = Q$ (4) $E_b + 3E_a = Q$
- In a fission reaction $^{236}_{90}\text{U} \rightarrow ^{117}\text{X} + ^{117}\text{Y} + n + n$
The binding energy per nucleon of X and Y are 8.5 MeV whereas of ^{236}U is 7.6 MeV. The total energy liberated will be about :
(1) 400 MeV (2) 200 MeV
(3) 300 MeV (4) 200 keV
- The binding energy per nucleon for a $^{12}_6\text{C}$ nucleus is
(Nuclear mass of $^{12}_6\text{C} = 12.000000$ a.m.u.
Mass of hydrogen nucleus = 1.007825 a.m.u.
Mass of neutron = 1.008665 a.m.u.)
(1) 2.675 MeV (2) 7.675 MeV
(3) 0 MeV (4) 3.675 MeV
- The atomic mass of $^{15}_7\text{N}$ is 15.000108 a.m.u. and that of $^{16}_8\text{O}$ is 15.994915 a.m.u. If the mass of a proton is 1.007825 a.m.u. then the minimum energy provided to remove the least tightly bound proton is :-
(1) 0.013018 MeV (2) 12.13 MeV
(3) 13.018 MeV (4) 12.13 eV
- If 1 gm hydrogen is converted into 0.993 gm of helium in a thermonuclear reaction, the energy released in the reaction is :
(1) 63×10^7 J (2) 63×10^{10} J
(3) 63×10^{14} J (4) 63×10^{20} J
- Thermal neutrons are those whose energy is about :-
(1) 1 J (2) 0.03 eV
(3) 1 MeV (4) 0.03 MeV
- Binding energy per nucleon versus mass number curve for nuclei is shown in the figure. A, B, C and D are four nuclei indicated on the curve.
The process that would release energy is :
(1) $C \rightarrow 2D$
(2) $A \rightarrow C + D$
(3) $A \rightarrow B + C$
(4) $B \rightarrow C + D$
- In a nuclear fusion reaction, if the energy is released then :
(1) $BE_{\text{products}} = BE_{\text{reactants}}$
(2) $BE_{\text{reactants}} > BE_{\text{products}}$
(3) $BE_{\text{products}} > BE_{\text{reactants}}$
(4) Mass of product > Mass of reactant



15. Nuclear energy is released in fusion reaction, since binding energy per nucleon is :
 (1) Smaller of fusion products than for fusing nuclei
 (2) Same for fusion products as for fusing nuclei
 (3) Larger for fusion products than for fusing nuclei
 (4) Sometimes larger and sometimes smaller
16. A heavy nucleus is unstable for any value of $\frac{N}{P}$ because :
 (1) Electrostatic repulsion dominate over nuclear attraction
 (2) Nuclear repulsion dominate over nuclear attraction
 (3) Nuclear forces are absent in heavy nucleus
 (4) Nuclear force is long range force
17. Which of the following statements are incorrect:-
 (a) the rest mass of a stable nucleus is less than the sum of the rest masses of its separated nucleons
 (b) the rest mass of a stable nucleus is greater than the sum of the rest masses of its separated nucleons
 (c) in nuclear fusion, energy is released by fusing two nuclei of medium mass (approximately 100)
 (d) in nuclear fission, energy is released by fragmentation of a very heavy nucleus
 (1) a, b (2) b, c
 (3) c, d (4) a, d
18. Highly energetic electrons are bombarded on a target of an element containing 30 neutrons. The ratio of radii of nucleus to that of Helium nucleus is $14^{1/3}$. The atomic number of nucleus will be:-
 (1) 25 (2) 26
 (3) 56 (4) 30

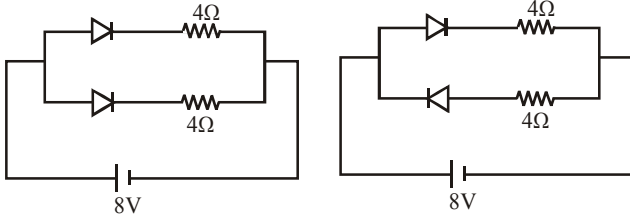
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans	2	2	4	1	4	4	1	2	2	2	2	2	3	3	3
Que.	16	17	18												
Ans	1	2	2												

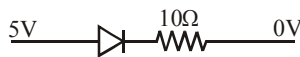
SEMICONDUCTOR & DIGITAL ELECTRONICS (DIODE)

RACE # 01

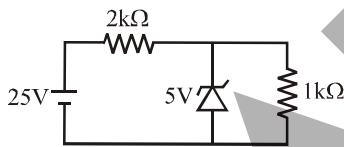
1. Current following in each of the circuit A & B respectively are :-



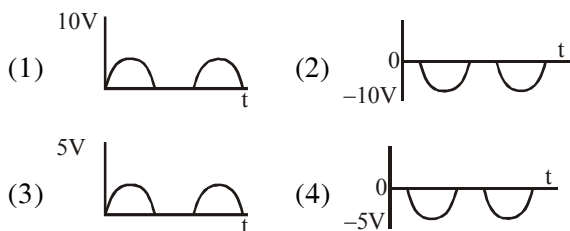
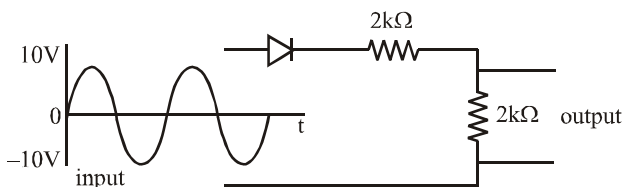
- (1) 1 Amp, 2 Amp (2) 1 Amp, 4 Amp
(3) 4 Amp, 2 Amp (4) 2 Amp, 4 Amp
2. A junction diode has a resistance of 25Ω when F.B. & 25000Ω when R.B. The current in the diode, for the arrangement shown will be :-



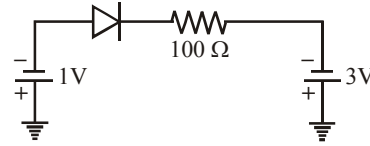
- (1) $1/15\text{ A}$ (2) $1/7\text{ A}$
(3) $1/25\text{ A}$ (4) $1/180\text{ Amp}$
3. Find current through zener diode :-



- (1) 5mA (2) 7.5 mA
(3) 2.5 mA (4) 12.5 mA
4. Find output wave form :-

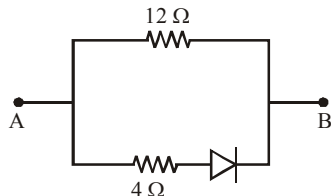


5. What is the current through an ideal p-n junction diode shown in figure below :-

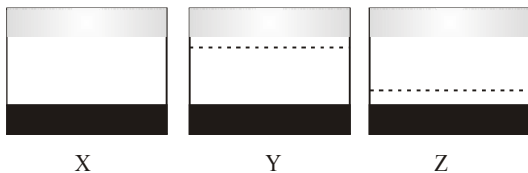


- (1) Zero (2) 10 mA (3) 20 mA (4) 50 mA
6. For a reverse biased diode, when the applied voltage is changed by 1 V, the current is found to change by $0.5\mu\text{A}$. The reverse bias resistance of the diode is :-
(1) $2 \times 10^5\Omega$ (2) $2 \times 10^6\Omega$
(3) 200Ω (4) 2Ω
7. Potential drop across a forward biased p-n junction diode is 0.7 V. If a battery of 4 V is applied, calculate the minimum resistance to be put in series, for the maximum current of 5 mA in the circuit.
(1) 660Ω (2) 350Ω (3) 475Ω (4) 500Ω
8. In a semiconductor diode the barrier potential offers opposition to only :-
(1) Majority carrier in both regions
(2) Minority carrier in both regions
(3) Free electrons in the n-region
(4) Holes in the p-region
9. A light emitting diode (LED) has a voltage drop of 2 V across it and passes a current of 10 microampere, when it is operated with a 6 V battery through a limiting resistor R. The value of R is :
(1) $10\text{ k}\Omega$ (2) $4\text{ k}\Omega$
(3) $200\text{ k}\Omega$ (4) $400\text{ k}\Omega$
10. In an intrinsic semiconductor, the density of conduction electrons is $7.07 \times 10^{15}\text{ m}^{-3}$. When it is doped with indium, the density of holes becomes $5 \times 10^{22}\text{ m}^{-3}$. Find the density of conduction electrons in doped semiconductor :
(1) Zero (2) $1 \times 10^9\text{ m}^{-3}$
(3) $7 \times 10^{15}\text{ m}^{-3}$ (4) $5 \times 10^{22}\text{ m}^{-3}$
11. In a semiconductor diode, the reverse biased current is due to drift of free electrons and holes caused by :
(1) Thermal excitations only
(2) Impurity atoms only
(3) Both (1) & (2)
(4) Neither (1) nor (2)

12. In a semiconductor diode, P-side is earthed and N-side is put at potential of -2 V , the diode shall
(1) Conduct (2) Not conduct
(3) Conduct partially (4) Break down
13. Find the equivalent resistance of the network shown in the figure between the points A and B, if (i) $V_A > V_B$ (ii) $V_A < V_B$

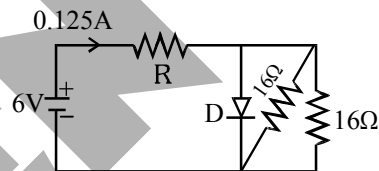


14. The energy band diagrams for three semiconductor samples of silicon are as shown. We can then assert that



- (1) sample X is undoped while samples Y and Z have been doped with a third group and a fifth group impurity respectively
- (2) sample X is undoped while both samples Y and Z have been doped with a fifth group impurity
- (3) sample X has been doped with equal amounts of third and fifth group impurities while samples Y and Z are undoped
- (4) sample X is undoped while samples Y and Z have been doped with a fifth group and a third group impurity respectively

15. The breakdown in a reverse biased P-N junction diode is more likely to occur due to :-
(a) large velocity of the minority charge carriers if the doping concentration is small
(b) large velocity of the minority charge carriers if the doping concentration is large
(c) strong electric field in a depletion region if the doping concentration is small
(d) Strong electric field in the depletion region if the doping concentration is large
- (1) a, b (2) b, d
(3) a, c (4) a, d
16. In the given circuit, the diode has a forward resistance of $8\ \Omega$ and infinite backward resistance. The value of R is :-



- (1) $44\ \Omega$ (2) $48\ \Omega$
(3) $16\ \Omega$ (4) $8\ \Omega$

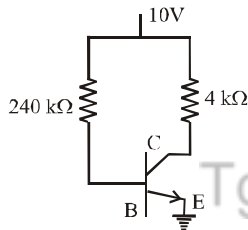
ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ans	3	2	1	3	3	2	1	1	4	2	1	1	(i) $3\ \Omega$ (ii) $12\ \Omega$	4
Que.	15	16												
Ans	4	1												

SEMICONDUCTOR & DIGITAL ELECTRONICS (TRANSISTOR)

RACE # 02

- Input resistance of Si transistor is 665Ω . Its base current is changed by $15 \mu\text{A}$ which result in the change in collector current by 2mA . This transistor is used as CE amplifier with a load resistance $5 \text{k}\Omega$ calculate :-
(1) Current gain β (2) Trans conductance
(3) Voltage gain
- A transistor has $\alpha = 0.95$. If emitter current is 10mA , what is (1) I_C , (2) I_B , (3) β .
- The power gain for CB amplifier is 800 & voltage amplification factor is 840. Find the collector current when the base current is 12mA .
- Calculate emitter current for which $\beta = 100$ & base current $I_B = 20 \mu\text{A}$.
- In given common emitter transistor circuit if base current is $40 \mu\text{A}$ & its current amplification factor is 50 then value of voltage across C & E is.



- The current gain for a transistor working as common base amplifier is 0.96. If the emitter current is 7.2mA , the base current will be :
(1) 0.42mA (2) 0.49mA
(3) 0.29mA (4) 0.35mA
- The value of current gain α for a transistor is 0.98. The value of β will be :
(1) 490 (2) 4.9 (3) 59 (4) 49
- A transistor with $\alpha = 0.98$ is operated in common emitter circuit with a load resistance of $5 \text{k}\Omega$. If the dynamic resistance of the base emitter junction is 70Ω , the voltage gain and power gain will be :
(1) $3500 : 1.715 \times 10^5$
(2) $4000; 2.715 \times 10^5$
(3) $2500; 1.215 \times 10^5$
(4) $2000; 2.215 \times 10^5$

- In which of the configuration of a transistor, the power gain is highest ?
(1) Common base (2) Common emitter
(3) Common collector (4) Same in all the three
- The current gain β of a transistor is 50. The input resistance of the transistor, when used in the common emitter configuration, is $1 \text{k}\Omega$. The peak value of the collector a.c. current, for an alternating peak input voltage of 0.01V , is :
(1) $100 \mu\text{A}$ (2) $250 \mu\text{A}$
(3) $500 \mu\text{A}$ (4) $800 \mu\text{A}$
- In a transistor the base is very lightly doped as compared to the emitter because by doing so:-
(1) The flow across the base region is mainly because of electrons
(2) The flow across the base region is mainly because of holes
(3) Recombination is decreased in the base region
(4) Base current is high
- Input signal to a common emitter amplifier having a voltage gain of 1000 is given by $v_i = (0.004 \text{V}) \sin(\omega t + \pi/2)$. The corresponding output signal is :-
(1) $(40 \text{V}) \sin(\omega t + \pi/2)$
(2) $(0.004 \text{V}) \cos(\omega t + \pi/2)$
(3) $(4 \text{V}) \cos(\omega t - \pi/2)$
(4) $(4 \text{V}) \sin(\omega t - \pi/2)$
- For a transistor amplifier power gain and voltage gain are 7.5 and 2.5 respectively. The value of the current gain will be :
(1) 0.33 (2) 0.66 (3) 0.99 (4) 3
- A common-base amplifier circuit contains input and output resistance of 200Ω and $100 \text{k}\Omega$ respectively. If the current gain is 0.98, then find (i) voltage gain (ii) power gain (iii) base current when collector current is 1.96mA .

ANSWERS

- | | | | | | |
|---------------|------------------------|------------|---------------|-------------|------------------------------------|
| 1. (i) 133.33 | (ii) $0.2 \Omega^{-1}$ | (iii) 1000 | 2. (i) 9.5 mA | (ii) 0.5 mA | (iii) 19 |
| 3. 240 mA | 4. 2.02 mA | 5. 2V | 6. 3 | 7. 4 | 8. 1 |
| 9. 2 | 10. 3 | 11. 3 | 12. 4 | 13. 4 | 14. (i) 490 (ii) 480 (iii) 0.04 mA |

1. If $A = 1, B = 0$ then in terms of Boolean algebra $A + \bar{B}$ equal to :-

(1) A (2) B (3) $\bar{A}$ (4) $\overline{A+B}$

2. Which of the following is not equal to 1 in Boolean algebra :-

(1) $A + 1$ (2) $A + \bar{A}$
(3) $A \cdot \bar{A}$ (4) $\overline{A \cdot \bar{A}}$

3. What will be the input of A and B for the Boolean expression $(\overline{A+B}) \cdot (\overline{A \cdot B}) = 1$?

(1) 0,0 (2) 0,1 (3) 1,0 (4) 1,1

4. NOT gates are connected at the two inputs of a NAND gate. This combination will behave as:-

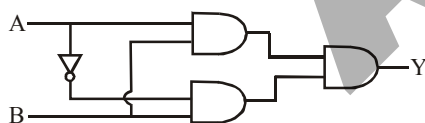
(1) NAND gate (2) AND gate
(3) OR gate (4) NOR gate

5. The output Y of the combination of gates shown is equal to :-



(1) A (2) B (3) $A + B$ (4) $A \cdot B$

6. Truth table for given circuit is :-



(1)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

(2)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

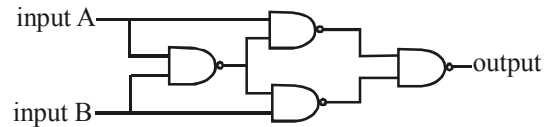
(3)

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	0

(4)

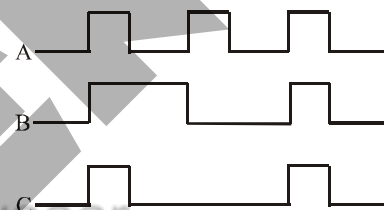
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

7. For the following combination of gates select the correct statement :-



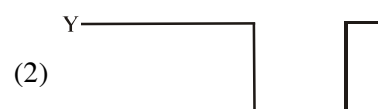
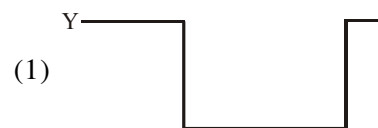
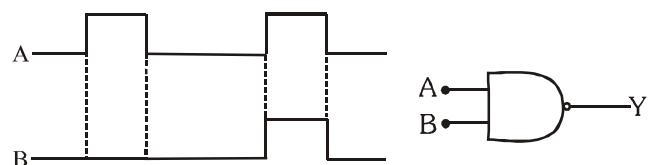
(1) The output is 1 when both the inputs are 1
(2) The output is 1 when both the inputs are 0
(3) The output is 0 when both the inputs are different
(4) The output is 1 when both the inputs are different

8. For a logic gate A & B are input and C is output voltage waveform then logic gate is :-

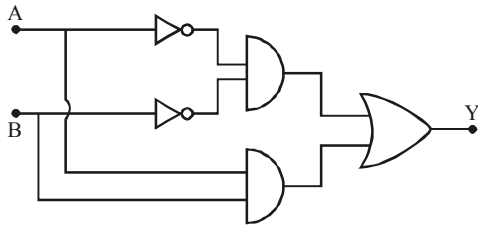


(1) OR (2) AND (3) NOR (4) NAND

9. If A and B are input voltage waveform for given logic gate then output voltage waveform will be:-



10. Write down the boolean expression for output Y of a system shown in figure.



- (1) $A\bar{B} + \bar{A}B$
 (2) $(\bar{A} - \bar{B})(A + B)$
 (3) $\bar{A}\bar{B} + AB$
 (4) $A \cdot B + (\bar{A} + \bar{B})$

Tg: @Chalnaayaaar

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	
Ans	1	3	1	3	2	3	4	2	2	3	

IMPORTANT NOTES

Tg. @Chalnaayaaar